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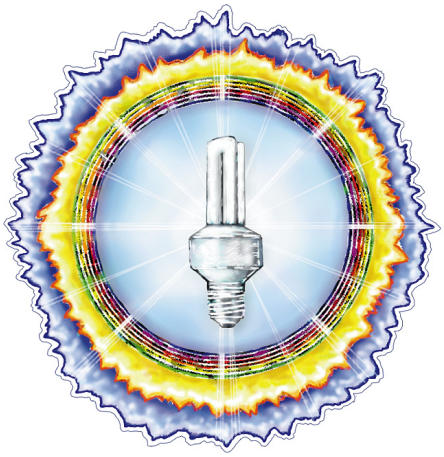
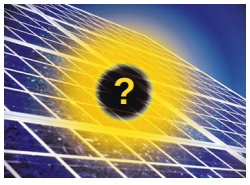


HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #42 August / September 1994



Features

GoPower

Things that Work!

Cover: (from top to bottom) Karen Perez, Silver Niewiadomski, and Jeremiah Niewiadomski climb the 80-foot tall wind generator tower at this year's Midwest Renewable Energy Fair. See page 22. Photo by Richard Perez

Fundamentals

Homebrew

Columns

Regulars

Access and Info

Access Data

Home Power Magazine
POB 520, Ashland, OR 97520
USA
Editorial and Advertising:
916-475-3179 voice and FAX
Subscriptions and Back Issues:
916-475-0830 VISA / MC
Computer BBS: 707-822-8640

Paper and Ink Data

Cover paper is 50% recycled (10% postconsumer and 40% preconsumer) Recovery Gloss from S.D. Warren Paper Company.

Interior paper is recycled (30% postconsumer) Pentair PC-30 Gloss Chlorine Free from Niagara of Wisconsin Paper Corp.

Printed using low VOC vegetable based inks.

Printed by

St. Croix Press, Inc.,
New Richmond, Wisconsin

Legal

Home Power (ISSN 1050-2416) is published bi-monthly for $15 per year at P.O. Box 520, Ashland, OR 97520. International surface subscription for $20 U.S. Second class postage paid at Ashland, OR and at additional mailing offices. POSTMASTER send address corrections to Home Power, P.O. Box 520, Ashland, OR 97520.

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Recycled Paper

Recyclable Paper

As revolutionary as a turnip

The object of revolution is freedom.

The turnips and other veggies in our gardens free us by giving us independent, home-grown food. Nothing is as good tasting, as inexpensive, or as good for us as the food from our own garden. Turnips free our planet by graciously participating in Mother Nature's ecological dance. Turnips don't pollute!

Growing our own food is revolutionary, both for us and for our planet. And food is just one specific form of energy which we daily require.

Energy can now be grown at home, just like our gardens. Tens of thousands of homes worldwide are now effectively powered by independent solar, wind or microhydro systems. These "energy gardeners" reap the freedoms of a reliable, cost-effective renewable energy source. Our planet is freed of the nasty messes associated with oil, coal, and nukes. Renewable energy systems don't pollute!

It's going to take some time for the word to get around. After all, don't expect either turnip or energy salesmen to let you know you can grow your own. So ask your friends, *"Did you know that a solar panel is as revolutionary as a turnip?"*

Richard Perez for the Home Power Crew

People

Tom Bennett
Sam Coleman
John Cowdrey
Michael Hackleman
Steen Hansen
Kathleen Jarschke-Schultze
Stan Krute
Don Kulha
Dan Lepinski
Dick Linn
Don Loweburg
Gail Lucas
Harry Martin
Jim Meurer
Therese Peffer
Karen Perez
Richard Perez
Shari Prange
Don Reichenbach
Alan Sailer
Bob-O Schultze
Tom Snyder
Michael Welch
John Wiles

" Think about it…"

"The white man knows how to make everything, but he does not know how to distribute it."

Sitting Bull

Solar Depot

Full Page
bleed top, right and bottom
full color

camera ready
on negatives

carry over from HP#41

This is page 5

Above: Sunlight is converted directly into electricity by sixteen photovoltaic modules providing over 3,500 watt-hours of power daily. This home is grid-connected and has cut its power bill by by 66%.

Adventures in Solar Land: *one man's story*

Alan Sailer

I'm a cautious, one-step-at-a-time kind of guy. A person who pulls Band-Aids off bit by bit and checks the water carefully with a toe before slowly wading into the pool. So, how did I end up here, writing under the light of a solar-powered light, in a solar powered house only fifty miles from downtown Los Angeles, right in the center of gridland? This solar stuff is for ex-hippies living in the middle of Eden, right? It all started with the used QuadLams that I saw on sale about two years ago. What a great way to check out solar power — start small, learn the ropes, and expand in slow, cautious steps.

Next, of course, I needed to get a charge controller, a few little batteries, and a tiny inverter. Just enough to power my stereo and a few lights, yeah, slow and careful, that's me. I really didn't plan on seeing that ad for a discounted, complete solar power system, only ten times larger than any of my original, logical plans.

So now, uncharacteristically, I find myself up to my neck in untested waters. Only, the water is warm, clear, and very pleasant. What's it like, you ask? Read on.

On a Clear Day You Can See the Sun Forever

After paying for the hardware and storing the pieces in the garage, my first question was...where? Light is the first priority. By using a Solar Pathfinder I was able to greatly simplify the search for an ideal panel location. The Pathfinder allows you to see, at a glance, what the ratio of shadow to sun will be, in any given location, over the entire year. I was able to rule out roof mounting due to several well-placed trees. Other promising locations proved to be too sun-proof. Finally, a slope top site about fifty feet from the house proved to be near perfect, with over 90% of those golden rays hitting silicon. As a great bonus, the slope runs along

an ideal east-west line, so that it faces due South. Eureka!

The location also helped dictate other aspects of the system design. Originally, I was planning on putting the batteries, charge controller and the inverter in the garage, with the solar panels on the roof. However, the distance between my ideal solar site and the garage was over one hundred feet — too much #2 copper wire for my budget. Since higher voltage means lower amperage, the next step was obvious: build the entire system on the top of the sloped hill and transfer the final 120 vac product down to the house. This lowered my wire requirements to fifty feet of #10 gauge, and cost much less money.

Stand By Me

The system that I am using at this time is the so called "stand-by" system. When I purchased the panels and batteries, I understood that they would not put out enough power during the winter months to supply all of our electrical needs (about 4 to 5 kilowatt-hours per day). So I decided to run the house on a mixture of grid and solar energy. Planning the mix took some time. I did *not* want to rewire the house, so all my planning took into account the existing ac wiring scheme. First, I inventoried all the ac outlets, 33 in all, by plugging a loud radio into each outlet and flipping circuit breakers until I heard silence. Each outlet is connected to one of ten sub-circuits or branches (each branch has its own circuit breaker in the main service entrance panel).

After mapping out each plug to its corresponding branch, I had to decide which branches should be solar and which should stay grid. Three troublesome appliances helped make the choices: a table saw, a laser printer, and the refrigerator.

The table saw was ruled out because of its high starting current, estimated at 60 to 70 amperes, or 8000 watts. The Trace 2524 inverter is rated to jump-start about 6000 watts, a good figure, but not enough. The inverter might be strong enough to soft-start the saw, but I decided that I didn't want to challenge the inverter with this load.

As for the printer, Trace does not recommend powering laser printers using their modified square wave inverter. Someday, someone is going to explain just what the problem is with thyristor input power supplies on laser printers!

Finally, the refrigerator is a notorious "non-solar" load. Since they run twenty-four hours a day, they often represent the single largest load in most households.

Below Left: Laurel Sailer and feline friend amid the photovoltaic modules.
Below Right: Alan Sailer.

Above Left: This system uses a power shed where the equipment is located remotely from the home.
Above Right: This small shed houses the batteries and inverter in separate, ventilated and insulated enclosures.

So, after a lot of figuring and fussing, I decided that five out of the ten existing branches would go solar. Grid back-up, in case of inverter/battery failure or bad, cloudy weather, is provided by two transfer relays that convert the house from half solar/half grid to all grid. When the switch to grid is made, the Trace inverter goes into battery charger mode. I also use this feature to equalize the battery bank every few months.

One final piece of luck was that the refrigerator ended up right between a solar plug and a grid plug. So, in the summer, when power is plentiful, I drink solar cooled, homemade (but that's another story) beer!

The Shack that Jack Built

Batteries are lead-heavy. Handling the load of sixteen Trojan 220 Amp-hour batteries is a six inch thick, wire mesh reinforced concrete pad. The walls are standard 2x4 frame construction, plywood outside, drywall inside with fiberglass insulation between to help keep battery temperatures below 80°F. The batteries sit on a wood platform insulated with styrofoam. This minimizes the thermal gradient between air and the cool concrete floor, protecting the battery life.

The inverter lives in its own compartment, with a wall keeping hydrogen gas out. All the seams on this wall were well sealed with silicone rubber caulking for the same reason. Solar ac from the inverter travels to the house down #10 stranded wire inside a buried PVC pipe. (Stranded wire is much easier to handle and pull through conduit — it's worth the extra price). At the house, two double pole, double throw relays and an ac sub-panel divide the house between grid and solar.

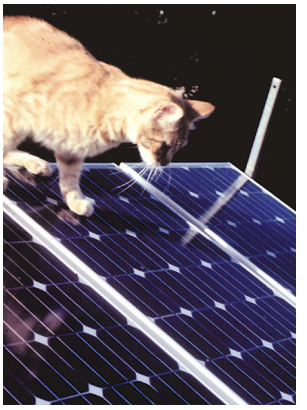
Excess space in the building is used to store emergency water, food, and supplies. We live in the center of earthquake country and most water is imported to Southern California. I am a far cry from a dyed-in-the-wool survivalist, but I will admit to fantasies of having the only lights on the block after the Big One hits. If my little solar shack is still up and running, I'll treat the neighborhood to a cup of solar brewed coffee.

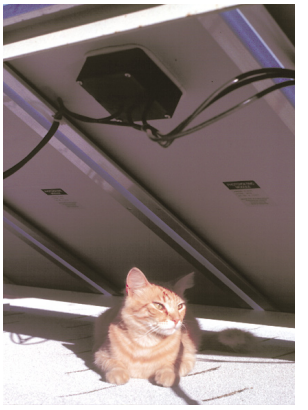
Frames for the sixteen solar panels were constructed from one inch angle iron, drilled and tapped for ¼-20 hardware. To help prevent galvanic corrosion between the aluminum module frames and steel supports, I isolated the two metals by using nylon washers. Before the modules were bolted in place, the frames were not very solid, but the final assembly is quite rigid.

The climate in Southern California is mild compared to many areas, so I don't recommend this style of construction for everyone. The worst weather these arrays have seen is 40 mph Santa Ana winds, which caused no problems at all.

The sixteen Hoxan 4810 panels are wired series-parallel in groups of four, to make a 24 Volt, six Amp array. Four arrays make up the power producing end of my system. On sunny days, I see a little over 24 Amps going into the SCI charge controller, so all that silicon must be doing its stuff according to specification.

I am still puzzling over the operation of the SCI charge controller. It appears to be working to specification, but does not easily bring the batteries up to full charge (specific gravity 1.265). On a typical sunny day, the controller stops full charge rate before noon and goes into float mode. At this point, the batteries are at a specific gravity of 1.250, which is not fully charged. All I can figure is that the design is meant to avoid any battery overcharge and excessive gassing, but I feel like it is wasting useful sunlight.





Above Left: A view of the PV modules' mounting structure.
Above Center and Right: When installing solar electric systems its helpful to have an experienced and able assistant.

The solar regulator and circuit breaker disconnects are installed in an exterior NEMA box, with the solar panel wiring coming in from downward facing conduit bend (keep that rainwater out!)

Ma Bell Meets Solar Man

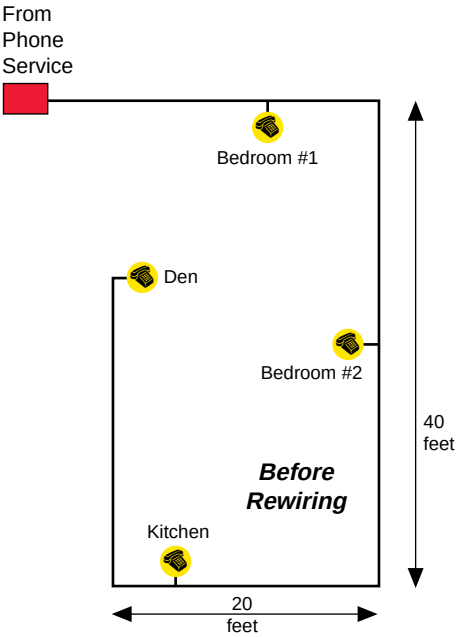
One unexpected byproduct of my new solar conversion is the inverter noise on the telephone wire. In hindsight, it is obvious that a modified sine wave inverter would put out a rich supply of harmonics above the basic 60 cycle waveform. About 30% of a modified sine wave is harmonic power. The harmonics that fall into the telephone systems operating frequency range (200 to 3000 Hz) can transfer onto the phone line and cause noise. In other words, inverter harmonics can couple onto the phone line and cause audio interference.

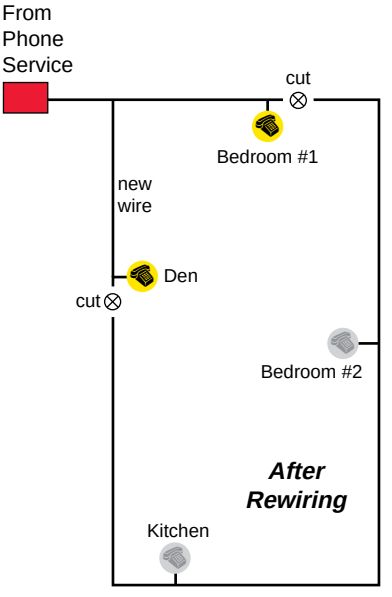
On my phone line, the interference sounds like a fast metronome clicking when the inverter is in search mode (i.e., the inverter is off, but waiting for an appliance or light to turn on). When the inverter is operating, the clicking noise turns into a steady buzz.

Getting the Buzz Out

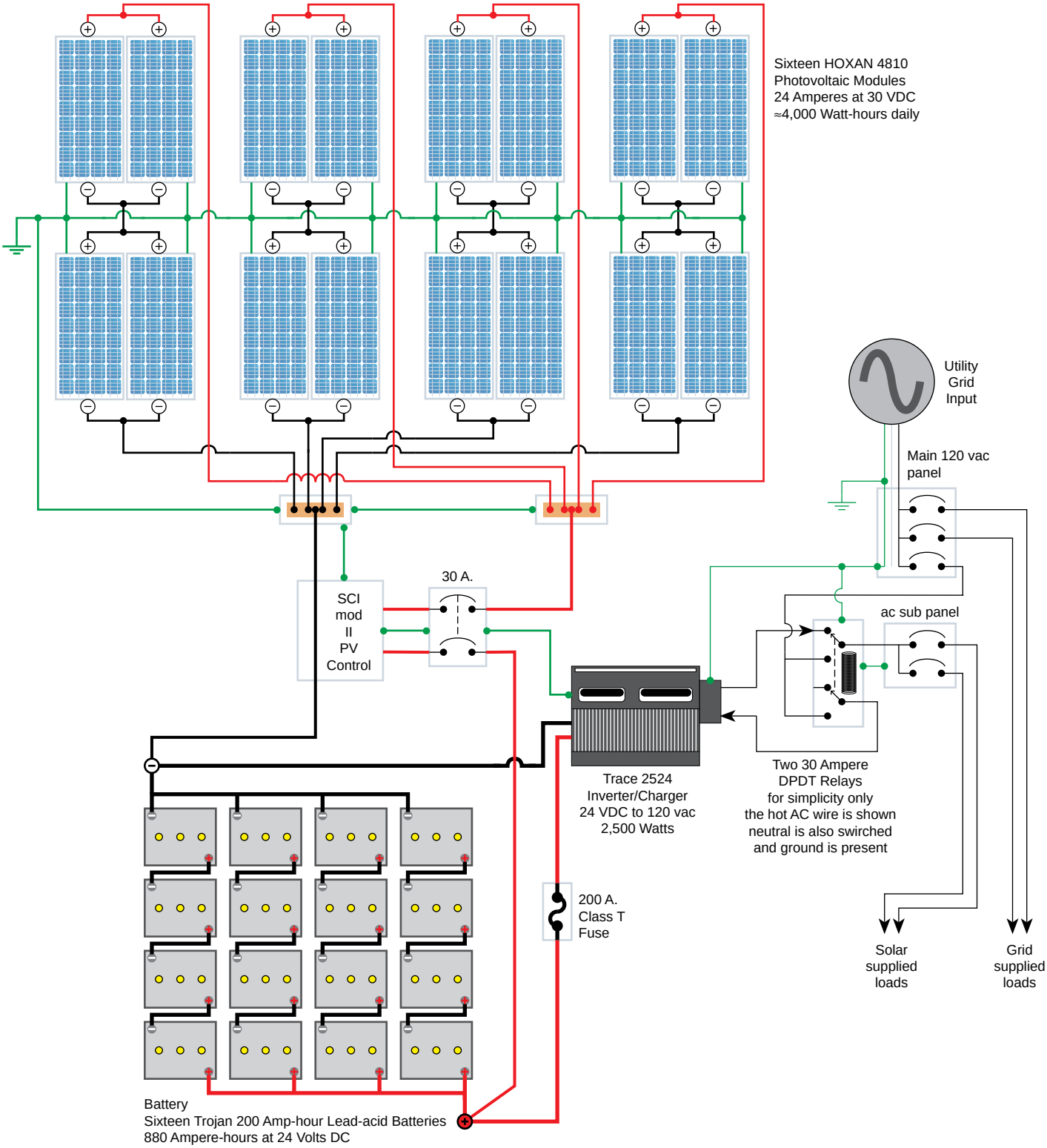
Fixing the inverter buzz took some detective work and about six hours of rewiring. By crawling around in the attic, I found that the phone lines needed major rerouting to avoid picking up interference from the inverter supplied 120 vac power wiring. As you can see from the diagram, the phone lines made a giant loop around the house, crossing the 120 vac power lines no less than ten times. The solution was easy since we decided that four phones were two too many. If we had retained all four phones, then the job would have been much more difficult — requiring rewiring and shielding all the phone lines.

The rewired phone line serves on the Den and Bedroom #1. The one new wire was carefully routed to avoid all 120 vac lines, but the phone in the Den still buzzed. Defeat? No. After replacing the Den phone (a cheap phone sensitive to interference) with a new $30 phone, the problem vanished. Now the only buzz is the busy signal or the dial tone. What a relief!





A schematic of Alan Sailer's RE System



Who, What, When, Where....
Why make the solar plunge here in the middle of Edison land? It wasn't to save money! Everything I read indicated solar watts would outcost grid watts by over two to one.

First, all the techno-dweeb learning that goes into building/installing solar systems is fun. I love working with my hands, making something new. From pouring the base for my solar hut to welding the frames for the panels, I got to do many things for the first time. If you like coming up with unique and creative solutions to mechanical and electrical problems, setting up solar power is great.

Second, I have been feeling frustrated for a long time reading about the environmental crisis facing our species. I don't want to get involved with politics and meetings trying to change the system, so I took the green statement, "Think globally, act locally" to heart. How much more local can you get than your own backyard?

Finally, I just plain like the sense of self-determination that solar power gives me. I am responsible for the safety and continuity of my solar power. My solar panels are like electric jewelry, always worth their weight in electrical power. If I ever get mad at the grid masters, the solution is sitting in my backyard.

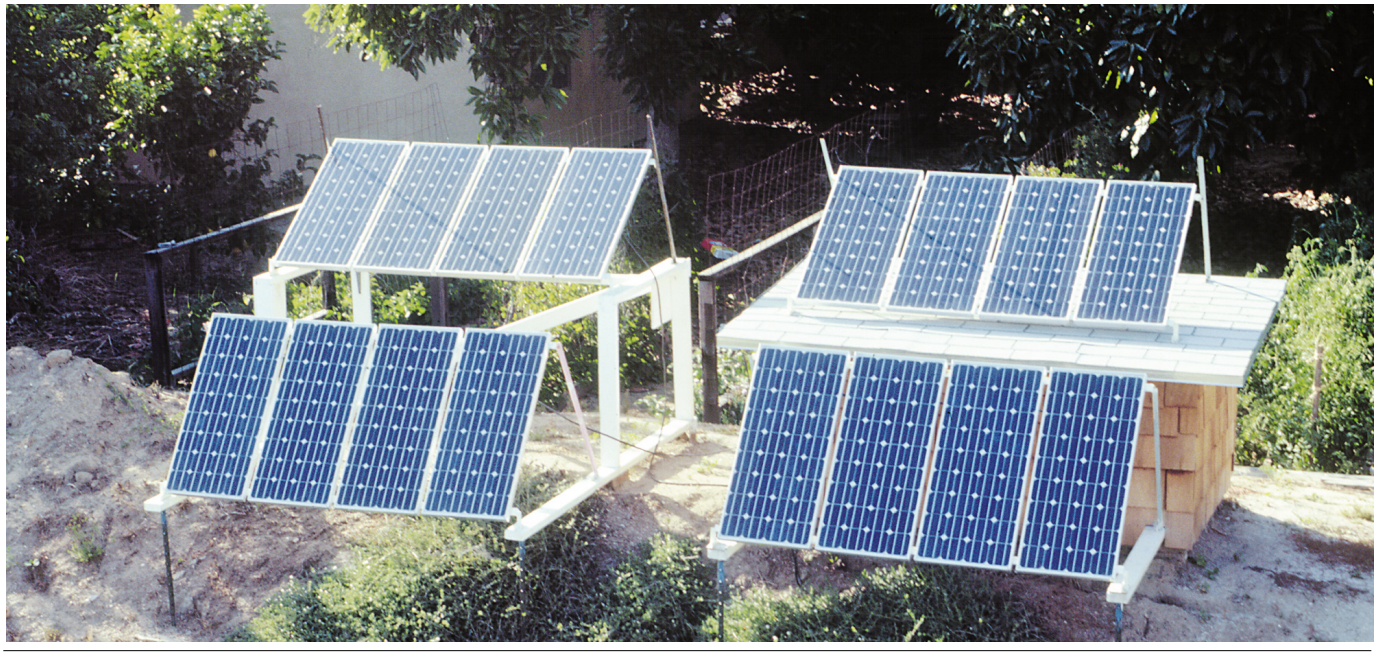
What's Next, Doc?
Yes, I'm not one to pull Band-Aids off with a clean jerk or jump head first into the swimming pool. Caution, check twice, and then do it. Now that I'm halfway into the solar world, what's next? For me, the plan is to get my energy production and energy consumption to meet halfway. As far as lowering energy consumption — replace the Kenmore refrigerator with a Sun Frost, and two, buy more compact fluorescent lights (right now I'm about half incandescent). Energy production is easy: more panels, more batteries, and a second inverter.

Longer term, I'd like to get a sine-wave inverter and build a mini-solar electric sub-system for the stereo and VCR. As for transportation: maybe enter the electric car world with a Eco-scoot style electric moped.

System Cost

Item	*Cost*	*%*
16 Hoxan 4810 PV Modules	$4,320	57.6%
Trace 2524 Inverter	$1,360	18.1%
16 Trojan 220 A-h, 6V Batteries	$1,152	15.4%
House Wire, Breakers and Mains	$300	4.0%
Battery House/Wire	$150	2.0%
SCI model 2 Charge Control	$120	1.6%
Module Frames	$100	1.3%
Total	$7,502	

Intangibles
What makes a canvas, covered with daubs of oil color, worth millions? Is the electricity from the sun worth the elevated price of admission? Yes, and both for the same reason — intangibles. Like watching the unchanging, slow spin of the grid meter as we turn on one light after another. Or reading a good book by the stored light of the sun, which long ago fell below the horizon.



During summer, our solar electric supply is running ahead of demand. I never made a load survey of our house (too lazy), just divided my monthly electric bill by days to come up with kilowatt-hours per day. At this time, my major solar loads are lighting, some tools, and the refrigerator. Non-significant loads are the vacuum cleaner, electric lawn mower, and the sink garbage disposal (used less and less with composting). I plan to add the microwave oven and possibly the washer/dryer at some future date, depending on how much current these appliances draw. We never did use a lot of electricity, but our electric bill has already fallen from about fifteen dollars to five dollars per month. (The local rate is about 10 cents per kilowatt-hour).

And what about those original QuadLams, the idea that started it all? Still in their box, up in the attic. Wasted? No, I think not. They got me started and I'm very happy where I've ended up.

Access
Author: Alan Sailer, 2299 Nequist, Camarillo, CA 93010 • 805-987-6003

A Shakey Final Note

The Northridge Quake of January 17, 1994 was centered less than fifty miles from our home. Although it caused little damage to the houses in our town, the quake did cut out electricity for the entire area. For obvious reasons we did not notice that the utility power had failed for over an hour. Our neighbors noticed and several stopped by to check out our solar oasis of light. By this time, Laurel was handing out inverter-brewed coffee to all our visitors. Several asked about solar energy as they sipped. All in all, a small (but good) demonstration of the benefits of energy independence.

Alan Sailer

10 June 1994

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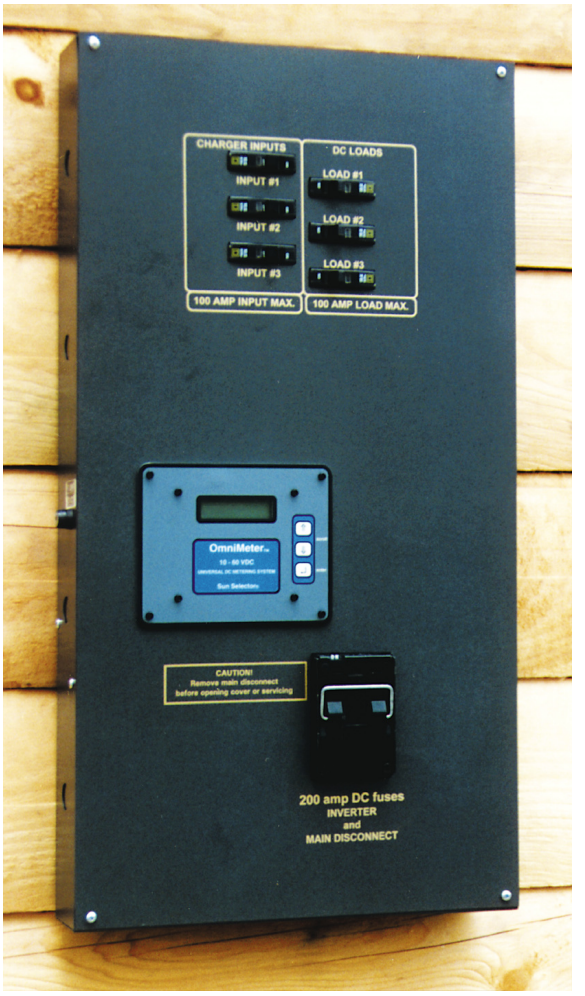

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HOMEPOWR on the Internet:

Newsgroup, Archives and Mailing-List

Don Kulha

For three years a wide-area conference named HOMEPOWR on renewable and home-scale energy systems has been offered on the FidoNet™ computer bulletin board system (BBS) network. HOMEPOWR promotes discussion of alternative energy and it's use. This conference has been quite successful and is carried by over 180 computer BBS systems in the U.S., Canada and Australia. It is also downlinked to BBS systems across North America via satellite by the "Planet Connect" system. As great as all this is, there are still many people around the world who would benefit from this information and who can't link in.

In order to bring about global discussion of renewable energy we've formed a new USENET newsgroup on the Internet, "**alt.energy.renewable**". The Internet is a global network via which over 20 million people can exchange messages, mail, and files. The current HOMEPOWR conference will be merged or "gated" to this new Internet conference. It is available now at many news sites. It may be necessary to ask the administrator at the Internet site you access to carry it.

An alternative means of participation is via the newsgroup almanac or "mailing-list". If you send a message to the almanac server and subscribe to the almanac copies of all messages posted to it will be forwarded to your Internet mail address. In turn messages you send to the almanac will be posted to the newsgroup and copies sent to all almanac subscribers.

To subscribe, send an email message to: **almanac@twosocks.ces.ncsu.edu** On the very first line of the body of your message type (all lower case) "**subscribe renew-energy**" (don't use the quotation marks). Once you are subscribed, the almanac server will send you mail once a day containing any new messages posted to the conference. Once subscribed, you can post new messages by sending them to "**renew-energy@twosocks.ces.ncsu.edu**".

All messages posted to the newsgroup will be archived and stored at "**sunSITE.unc.edu**" and are available via gopher, telnet or FTP in the directory: "**pub/academic/environment/alternative-energy/energy-resources/discussion-groups/newsgroups/alt.energy.renewable**". We have also placed back issues of *Home Power Magazine* there as well as many other energy related files. The Sunsite archives contain a wealth of information on many subjects including environmental and sustainability issues.

We're doing our best to make this information and these conduits of communication readily accessible to the global community. By doing so we leverage and increase its value enormously. We look forward to seeing you on the net and together working to build a more sustainable and appropriate energy future.

Many thanks to the folks who have helped us bring this project to life: the Home Power Crew for their inspiration, support, and the great information they have shared; to Lawrence London who helped get the new newsgroup launched on the Internet, made arrangements for the almanac server and has posted the information we've sent him to the archives at sunSITE; to Michael Welch at Home Power BBS; and to the administrators of the sunSITE system at the University of North Carolina for providing access to and space for the file archives. Finally our thanks to the many participants of the HOMEPOWR conference who have shared our vision and helped us grow a vital online forum.

Access

Author: Don Kulha, HOMEPOWR Moderator, Sonoma Online BBS @ (707)545.0746 (4 lines, 24 hrs @ V.32bis) or via the Internet: **dkulha@crl.com**

Lawrence London (**llondon@sunsite.unc.edu**) for questions regarding the almanac mailing list and file archives at sunSITE

Home Power BBS @ (707)822.8640 (2 lines, 24 hrs @ V.32bis)

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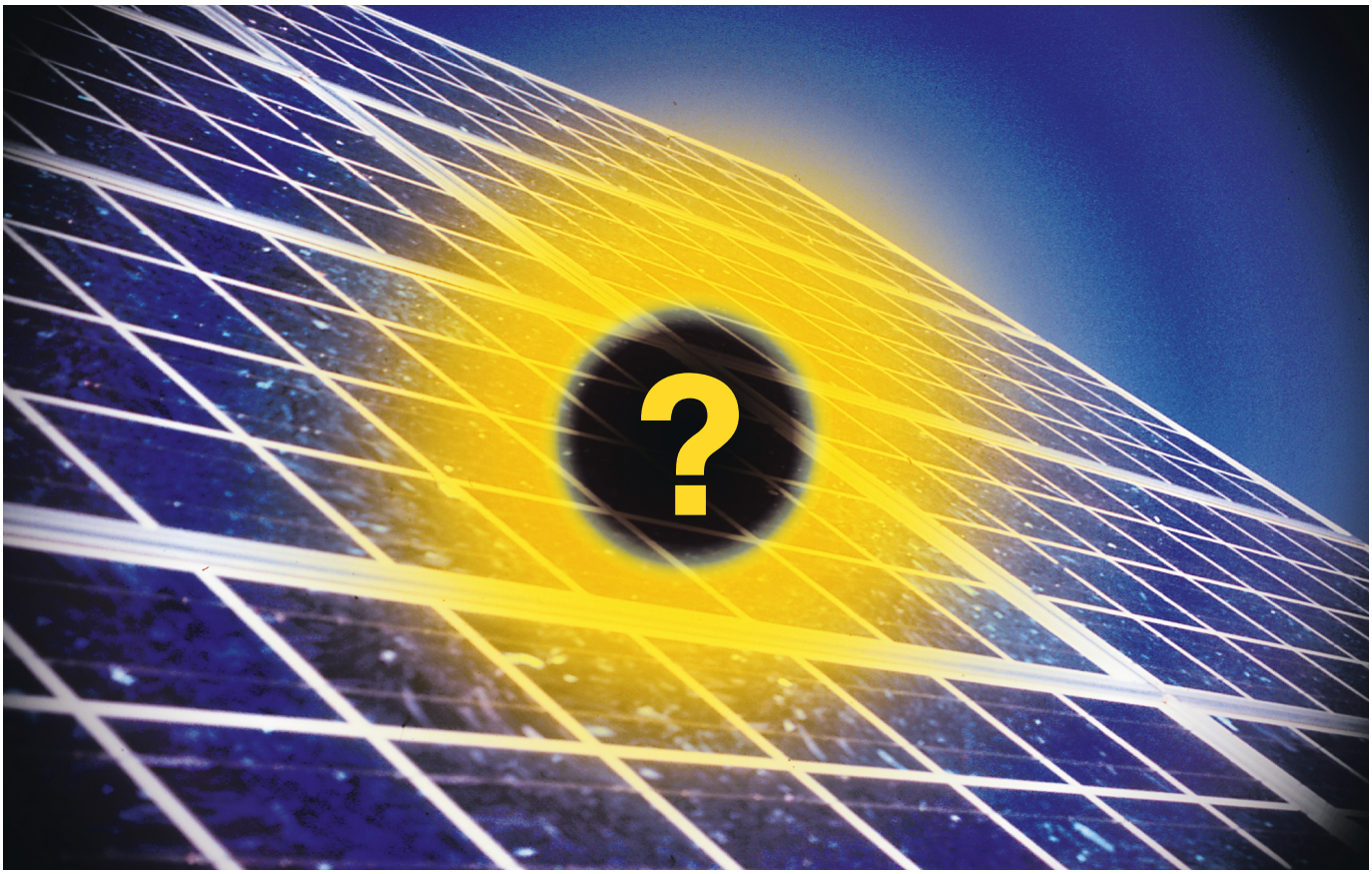

Renewable energy needs your input!

Please fill out this survey and mail it in!

Home Power is conducting a survey about energy satisfaction. We are interested in how you get your energy and how satisfied you are with your energy sources. We are also interested in how you view the future of renewable energy.

Please note that the energy consumption figures in this survey are expressed in kilo-Watt-hours per day. If you buy your power from a utility, then this information is printed on your power bill as KWh per month, so divide by 30. If you live on renewable energy, then we understand how difficult it is to measure power consumption, so please provide us with your best estimate.

The back side of the survey form asks you to rate your preferences about the future ownership of renewable energy.

We will tabulate this data and report on the survey in the October / November 1994 issue of Home Power (HP#43). Your name and street address is not required, but please include your zip code (inside USA) or country (outside USA). The information gathered in this survey will not be sold, but provided free of charge to all who are interested. This survey is not connected with, or paid for by, any utility or utility group.

We at Home Power have some very definite ideas about “who owns the sun”, and we would like to know your opinions. Thanks for making your voice heard, and for helping out.

Richard Perez for the Home Power Crew

AAA Solar

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Retirement Off the Grid

Don Reichenbach

Retirement is something we all talk about, but seldom do anything about. I was no different. Retirement always seemed like it was so far away and there was still plenty of time to make preparations. Well, let me tell you something, "T'ain't So!"

My wife Pat and I had good jobs which put us in the upper middle income bracket. We lived the "good life", which now too often means, doing most of the things you want to and buying whatever strikes your fancy with nothing left over for the future. We were heavily involved doing just that when suddenly Pat's company closed their plant and gave her the option of early retirement or relocation. She accepted the "early out".

Facing Facts

We faced the facts — our income was drastically reduced as Pat's pension amounted to only a fraction of her former salary. I still had two years to go before I could retire. Worst of all, we had put nothing away for the future, which was suddenly staring us right in the face! We had to make some decisions immediately!

We sat down and took stock of our assets — seven and a half acres of vacant land way out in the "boondocks" in the Kern River Valley which was paid for, ten additional adjoining acres on which we owed a modest amount, Pat's severance pay, some income tax refund money, and finally, an overwhelming urge to "get away from it all." The fact that we only had two years to do what we should have been doing for the last twenty years urged us on.

First Things First

We agreed that water was the single most important ingredient that we lacked. We contacted a local well driller. He informed us that he would be happy to drill our well for the miserly sum of $21.50 a foot plus the cost of the pump, plumbing, and permits! We were momentarily staggered, but with the knowledge that most wells in our area were producing water at about a hundred feet we decided to go for it. You guessed it! Three hundred and twenty-seven feet and a severe case of jangled nerves later, we were the proud owners of an expensive hole in the ground that produced a not very impressive seven gallons a minute.

Above: Don and Pat Reichenbach with their 44 year old tractor named Clyde.

We now had a well, which had cost about twice what we had planned on, but still no way to get the water out of the ground. Knowing that on our budget, commercial power was out of the question, I set out to learn about generators. About a hundred telephone calls and three books later, I had decided that we should go diesel. I soon found out that deciding was easier than finding a suitable generator that we could afford. Our broker mentioned that he had a 1984 six thousand watt Onan diesel that was still in the crate and, because it was six years old, although unused, he would let me have it for $3,400. By that time I was desperate so I did not even haggle. That turned out to be one of the best investments we made! We now had water. One of our neighbors agreed to build a pump house in exchange for an old trailer.

Getting Ready

We now started planting trees. We hoped the trees would be big enough by the time our mobile home was sited, two years hence, to provide some semblance of an oasis in the otherwise rather sparse looking environment. We made the 200 mile round trip every weekend to water our newly planted forest. After the second trip we realized that it was not often enough nor could we afford to keep doing it all summer. Pat volunteered to spend the next two summers camping out in our motor home to do the watering and deal with the county authorities about permits and things. It turned out that the watering was the easy part!

Above: The pump house with PV modules on its roof, and the water storage tank.

Going Solar

It didn't take long to realize that we couldn't keep starting the generator every time we wanted to water or even to get a drink! That meant a storage tank and some pressure tanks — more expenses! After the tanks were installed, we still had to transfer the water from the storage tank to the pressure tanks. This is the point at which we started to go solar.

We already had two ARCO M78 photovoltaic modules that we had purchased one time when they were on sale. I called the folks at Flowlight and they recommended their Booster Pump. When the pump arrived I installed it according to their instructions, using a standard fuse box with 20 Amp slow blow fuses. I installed the panels on the roof of the pump house and connected them with #10 gauge wire to a 15 Amp SCI charge controller and thence to a pair of 220 Amp-hour 6 Volt Interstate golf cart batteries. The only "frill" was an ammeter I put in so I could tell by the increased amperage of the pump when I needed to change the pump's filter. Pat almost single-handedly dug the trenches and laid the water lines to the house site. We could now turn on a faucet and get water without having to start the generator. The path was open for the next phase of our plan — securing the permits and starting on the site preparation.

Legal Access

The whole next winter and part of the summer was spent trying to satisfy the authorities' requirements for a "legal access". Although our road has appeared on Bureau of Land Management maps for the last 33 years, the county would not recognize it. Check closely for "legal access" before you buy property or you will find out first-hand how much of a hassle it can be!

Retirement

Retirement was suddenly only a month away, so we put our home up for sale. We hoped to realize enough profit on the home's sale which when combined with my accumulated vacation pay would allow us to pay cash for our retirement home. Our whole strategy depended on this — by taking early retirement my pension would not be large enough to make mortgage payments. My retirement day finally came, and as luck would have it, the house sold very shortly thereafter.

As is usually the case, we didn't make quite as much on the house as we had hoped, nor did I get as much as planned in vacation pay. Nevertheless, we took cash in hand and went to see a local mobile home dealer. We picked out a very modestly priced two bedroom, two bath home with no extras other than the "desert pack" insulation and double pane windows. It's truly amazing how much things like dishwashers and garbage disposals add to the price of a home. We were very fortunate to get a salesman who was able to understand that when we said that we expected to have this home installed on our site, ready to move in for the stated price with no ups, we really meant it. I am absolutely positive that there were unexpected costs, but knowing that he would lose the sale if he passed them on, he chose to absorb them. There really are honest salesmen who keep their word out there, it's just hard to find them sometimes!

Moving In

Within three weeks we moved into our new desert home. At first it was like camping out, only with a bigger tent. We had no power at all. We used kerosene lamps and flashlights at night and listened to the battery powered radio. I traded with a neighbor and obtained an old generator (emphasis on *old*, I believe it must have been the backup unit on the Mayflower). Anyway, I hooked it up to the house and we had power on demand, every so often when it chose to run. Looking back, I guess it wasn't all bad, as I learned an awful lot about fixing ancient generators.

Solar for Real

Electric lights and TV aren't really necessary, but we craved them, so once again it was time to go solar. Pat worked for a while at a new restaurant in town and we had saved all of her earnings so we were able to buy enough to get started. We purchased a set of ARCO QuadLams, another SCI 15 Amp controller, and a pair of Trojan 220 Amp-hour 6 Volt batteries. I mounted the QuadLams on a home-made rack in the front yard and ran #10 gauge wire to the controller in a weatherproof box next to the house. The same box also contained a fuse panel from an old truck out of the wrecking yard. This panel allowed me to fuse each line into the house

individually. The batteries were contained in a separate insulated, vented box next to the controller. This setup powers three 12 V fluorescent lights, an antenna booster, a 12 V color TV, a Citizen's Band two-way radio, a scanner, and a stereo radio. We were now living in comfort.

We have since added another ARCO M75 PV module to the pump array because we have planted so many more trees that the booster pump needed more power to keep up. We have also added three ARCO M75 PV modules to the house array to accommodate a Statpower Pro-watt 250 inverter which powers a 19 inch color TV and my word processor. I figure that we have about $2,100 invested in our solar equipment.

Summed Up

It is possible to retire "off the grid" and live comfortably even if you don't plan ahead, but believe me it's going to be much easier if you do some advance planning. There is more to it than I have been able to mention in this article, so feel free to contact me. If I can help you in any way I will be more than happy to try.

Access

Author: Don W. Reichenbach, 30121 Hwy 178, PO Box 24, Onyx, CA 93255 • 619-378-4811

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1994 Midwest Renewable Energy Fair

Richard Perez

More than 8,000 people attended this year's fifth annual Midwest Renewable Energy Fair (MREF) in Amherst, Wisconsin. The theme of this fair is continuing education. Ninety-three different workshops, each happening two or three times during the fair, informed all who would listen. The message delivered by the fair was simple, "Renewable energy works — we've been living with it for years — and you can too."

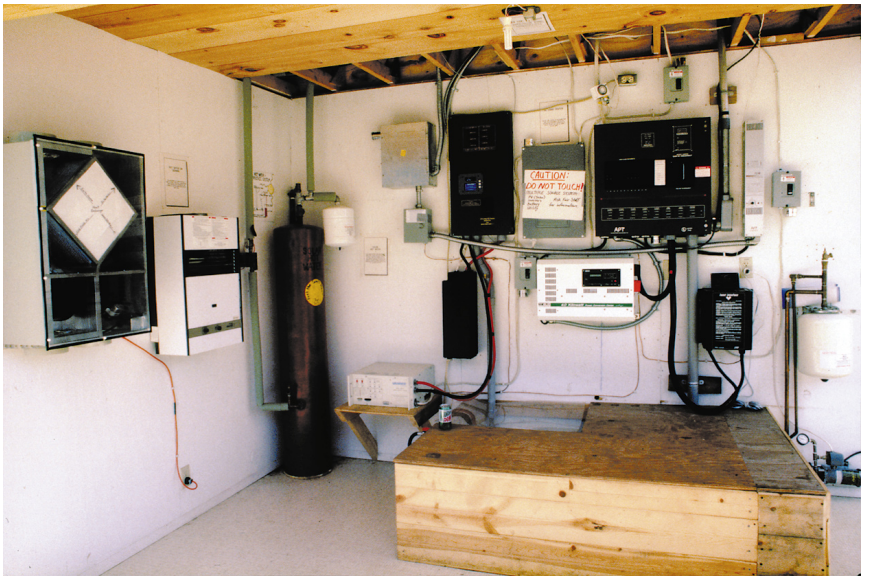
The MREF Spirit

This year's MREF was festive and relaxed. Fun flowed freely amongst a crew that was delirious just to have the sun shine on this event. This fair had been severely drenched during three out of the last four years. The continuing success of the MREF Crew has made the fair's atmosphere smooth and comfortable. Everyone wore a big "Been there — Done that" smile. A good example of this spirit was the Rad Waste Disposal Booth.

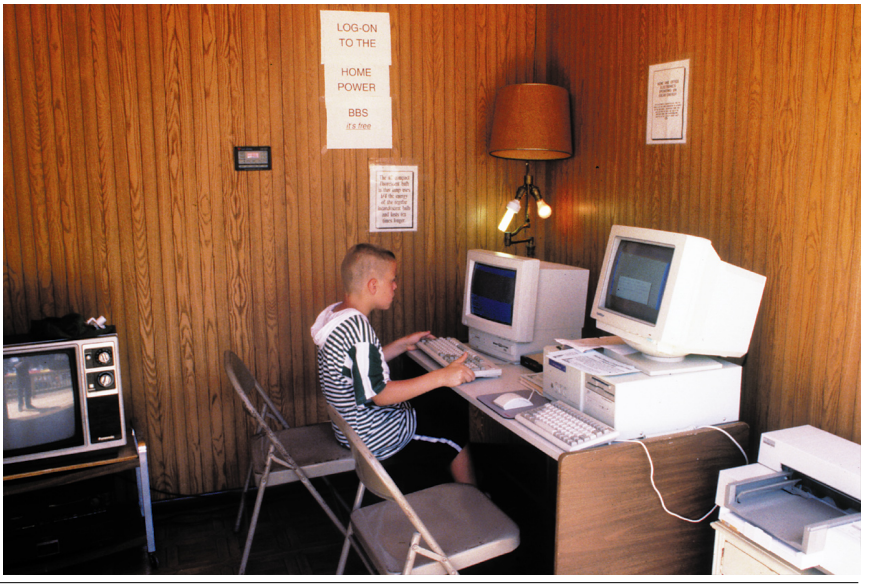
The Rad Waste Disposal Booth was a splendid spot of guerrilla theater urging fair goers to “take home some rad waste for your back yard.” Rogers and Kaaron Keene would dip deep into the nuclear cooling tower and come up with a bogus pellet of nice hot “rad waste”. This pellet was encapsulated into a small plastic box for the fair goer to transport home and plant in his own back yard. The message was, “Be a good American, help out by saying, ‘Yes, in my back yard!’” Everyone taking home a rad waste pellet got to put a red sticker indicating their location on a U. S. map. By the end of the fair the map had nationwide measles. See the photo (right, top) for a static view of Rogers and Kaaron in action.

The Model Home

Every year MREF’s model home becomes larger and more detailed. This home displays the most energy efficient technologies available. It amazes me that the MREF Crew has the energy to set up and take down this very elaborate demonstration of home energy efficiency — just for the weekend! The Midwest Renewable Energy Association has decided to look for a permanent location for this model home, the fair itself, and for ongoing renewable education. These folks are looking ahead to a permanent site where they can set up a campus, powered by renewables and displaying energy efficiency and ecological awareness. Based on what they accomplish for just a weekend, I image that their new permanent home will really be something to behold.

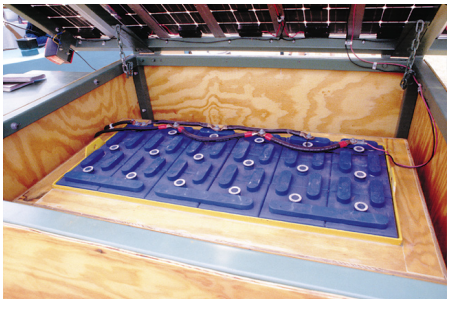


This year’s home featured a renewable energy system using the very latest equipment. Energy was provided by a large photovoltaic array and a wind generator. The system was also utility intertied. Four inverters supplied power to the model home and nearby booths. The home also used solar hot water, super-insulation, efficient lighting and windows, as well as energy saving kitchen and bathroom appliances.



Above left: Mickey Wurl-Koth talks with customers at the Solar Spectrum Booth.
Above center: Dan Allway of Low Keep Refrigeration displays his 12 VDC refrigerator and chest type freezer.
Above right: The Gimme Shelter Crew show off a masonry heater and efficient home construction.

Above left: Burn corn instead of wood. All renewable technologies are demonstrated at the MREF.
Above center: Darlene and Cliff Millsapps, makers of the Solar Pathfinder, sold out their entire stock during the fair.
Above right: This spiffy old Renault was just one of many electric and alternative fueled vehicles at the fair.



Above left, center and right: Steve Fox of Wyoming, Michigan demonstrates his portable PV power system. This system on a trailer uses eight modules, a 1000 Amp-hr. battery and an Exeltech sine wave inverter. Steve powered seven solid hours of live electric music with this system last Earth Day. The workmanship is first class!

Left: Alfonso Lazano and the Solartek Crew came all the way from Baja California to show off their new patented PV tracker. Look for this low cost tracker soon inside the USA.

Center: Gunnars Peterson of Alternative Power & Light had a great sign.

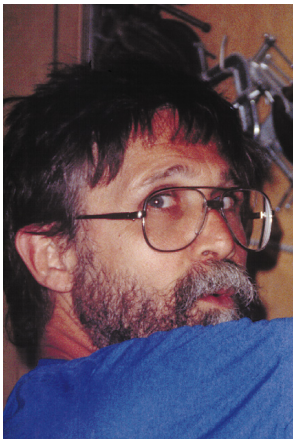
Right: Phil Manke demonstrates his solar-powered Stirling engine

Since Home Power's booth was located directly across the lane from the model home, I got to observe well over two thousand people tour the home during the weekend. MREF staffers would lead these tours and explain the operation, benefits, and costs of all home's features. The home was constantly filled with people, so I had to shoot the photos you see here early Sunday morning (power room — pg. 23 center).

The living room contained two computers. One computer was logging the performance of the various electrical systems and displaying the data as colored graphs on the screen. The second computer was hooked into the Home Power Bulletin Board System (HPBBS) in Arcata, California. Many fairgoers paused to take in the wealth of information being spewed out of these computers. The young gentleman pictured here (pg.23, bottom) got up early for an extended look at the information on the HPBBS.

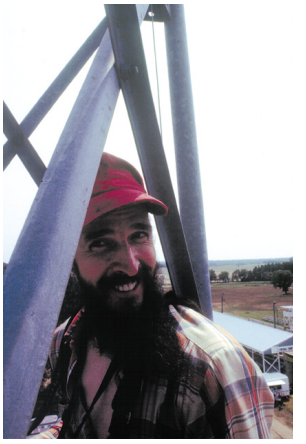
The Workshops

If you spent every moment at the fair attending workshops, then you still could only possibly attend 15% of the workshops that were offered. The educational opportunities were astounding and overwhelming. This is another reason that the Midwest Renewable Energy Association is establishing a permanent campus — a weekend is far too short to learn all they have to teach. The quality of the workshops was very high. In many cases the person teaching the workshop pioneered the technology being taught. For



Above left: Lake Michigan Wind & Sun's wind generator supermarket. Just about every commercially available wind generator was there for public examination.

Above right: Mick Sagrillo, noted wind generator maniac and MREA President.



Above left: The view from the Big Jake's 80 foot tower was amazing. Visible below is the alternative transpo section, the giant PV array, and the Whisper 1000.

Above right: Many thanks to my friend Silver Niewiadomski for talking me into climbing the tower. The view was more than worth the effort.

Above right: The Niewiadomski Family and the Home Power Crew. The collection of folks in this photo taught 26 workshops during the fair.

Above right: Sunday after the fair closed the various crews got together in front of the model home to talk, eat yard long sandwiches, and make live music. The festivities lasted 'til long after dark…

example, Joe Bobier of SunSelector taught courses on long distance DC power transmission, Don Harris of Harris Hydro taught courses in micro hydro, and Bob Hoffman of Midway Labs taught courses on photovoltaic concentrators. It was no wonder that most workshops were standing room only.

The fair may have ended, but the workshops are still going on! The Midwest Renewable Energy Association is continuing with these workshops through the summer and into the fall. Only instead of an hour and a half to deliver the information, we'll have an entire weekend. See the MREA ad on page 95 for course details, dates and logistics.

Wheeling and Dealing

Over 90 businesses setup displays for this year's MREF. Trading was hot and heavy with folks carting home everything from compact fluorescent lamps to 10,000 Watt wind generators. The word is out, if you want good deals on hardware, then go to an energy fair!

Tired, but happy…

It was a whirlwind, high-energy, weekend in America's Heartland. Where else can you hear Amory Lovins discourse on "Negawatts, Renewables and Economics", attend a workshop about cooking with a solar oven, take a ride in an electric vehicle, and save fifty bucks on a PV module?

I salute the Midwest Renewable Energy Fair Crew for their untiring dedication and hard work. In five years, these folks have built the finest energy event in America. Their "you can do it too" message is being heard and realized nationwide. Julie Weir, Executive Director of the Midwest Renewable Energy Association deserves special recognition — she makes it all come together. Next year's MREF is scheduled for June 23–25, 1995. See you there!

Access

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Midwest Renewable Energy Association, Box 249, 116 Cross Street, Amherst, WI 54406 • 715-824-5166

M.R.E.A. 1994 Summer & Fall Workshop Series

In response to growing interest in these in-depth, hands-on workshops, the MREA is continuing their education workshop series.

August 13 & 14 — Photovoltaic Powered Home Systems — Jim Kerbel, Photovoltaic Systems, Amherst, WI. Workshop located in Amherst, WI.

August 26 & 27 — Home-Sized Wind Systems — Mick Sagrillo, Lake Michigan Wind & Sun, Forestville, WI. Workshop located in Forestville, WI.

September 10 — Window Quilting for Moveable Insulation — Beverly Nelson, Stevens Point, WI. Workshop located in Stevens Point, WI.

September 17 & 18 — Residential Solar Domestic Hot Water — Richard Lane, Packerland Solar, Green Bay, WI. Workshop located in Green Bay, WI.

September 23 & 24 — Wind/Photovoltaic Hybrids — Mick Sagrillo, Lake Michigan Wind & Sun, Forestville, WI and Jim Kerbel, Photovoltaic Systems, Amherst, WI. Workshop located in Forestville, WI.

September 30-October 2 — Batteries and Inverters, applications for home-sized systems — Richard Perez, Home Power, Ashland, OR. Workshop located at Treehaven Learning Center, Tomahawk, WI.

October 14-17 — How to Build an Affordable Natural House Using Timber Frame, Straw/clay, Earth Plaster, and Earth Floor — Robert Laporte, Natural House Building Center, Fairfield, IA. Workshop located in Amherst, WI.

October 22 — Residential Solar Energy — Doug Steege, Altech Energy, Madison, WI. Workshop located in Madison, WI.

November 11, 12 & 13 — Introduction To Renewables — Mick Wurl-Koth, Solar Spectrum, Tomahawk, WI. Workshop located at Treehaven Learning Center, Tomahawk, WI.

For more information see MREA's full-page ad on page 95 or contact:

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Richard Perez

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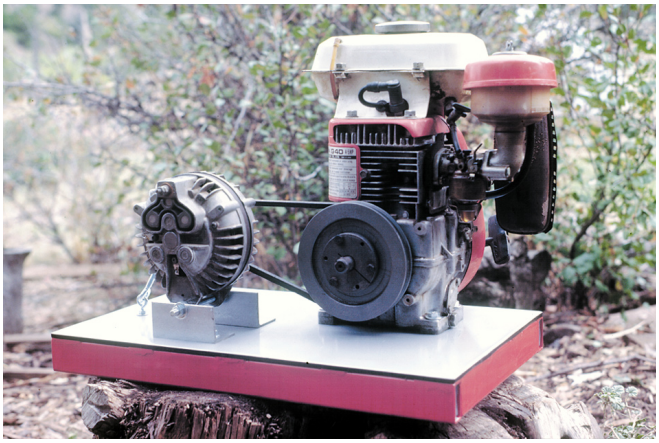
Engine/Generator Overview

I have built a dozen versions of this power plant in the last twenty years — three for myself and others for neighbors. Over the years the design has evolved, but the purpose remains the same — on-demand battery recharging and equalization. A version of this article first appeared in *Home Power* #2 — our most requested out-of-print back issue. Here is a revision of this information with an updated regulator design.

In the early days (1982–1985), we used this type of engine setup as a prime mover. It supplied almost all of the energy for our system. We only had two PV modules at the time. As our PV/wind system grew, our dependence on the engine faded. Now we only use it during the depths of winter to meet those cloudy, all-night deadline sessions. From this experience we learned that while an engine is still a great energy back-up, it is a miserable prime mover for the system. These units are most effective if used less than 200 hours yearly. Using the generator as the primary power input will yield 1,000 to 2,000 hours of engine operation yearly — a nightmare of expense, maintenance, and pollution.

Source Capacity and Flexibility for Battery Equalization

Every RE system should have at least one power source capable of recharging the batteries at between C/10 to C/20 rates of charge. For example, a battery pack of 700 Ampere-hours periodically needs to be recharged at a minimum of 35 Amperes (its C/20 rate). To figure the C/20 rate for your pack, simply divide its capacity in Ampere-hours by 20. The resulting number is the C/20 rate in Amperes. The C/20 rate is optimum for equalizing charges. An equalizing charge is a controlled overcharge of any already full battery. If your RE sources are not powerful enough, or flexible enough, to equalize the battery, then this engine-driven source can do the job.



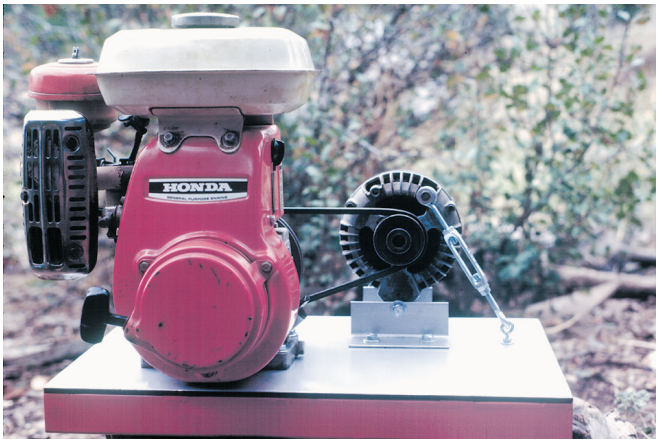
Above: This engine/generator uses a Chrysler 70 Ampere alternator.

Power Source Control

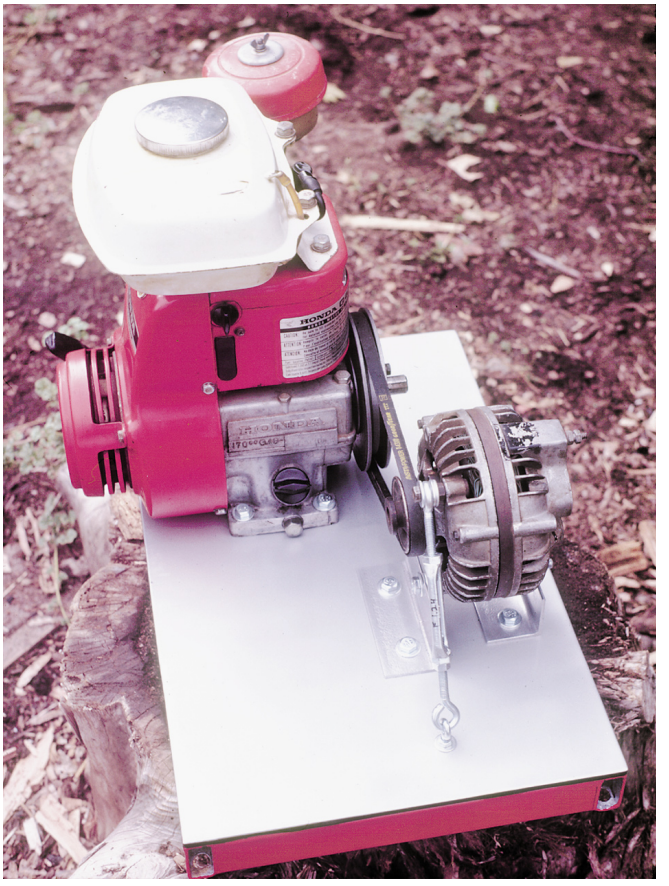
Energy sources which recharge batteries need to be controlled. If the charging source is not controlled, then the batteries may be overcharged or recharged too rapidly. The most common method of control is voltage regulation. This works fine in cars and in batteries with shallow cycle, float service. Voltage regulation alone is not enough for deeply cycled batteries. They must also be current regulated to prevent too rapid recharging.

Voltage Regulation

Voltage regulation only is OK for batteries that are very shallowly cycled. In shallow cycle service the battery refills almost immediately since it has only had a small amount of its stored energy removed. In deep cycle service the batteries have had about 80% of their energy removed before recharging. If deep cycle batteries are recharged from a source that is voltage regulated, they will be charged at the total output current of the source as it struggles to bring the batteries immediately to the set voltage limit. If the charging source has say 55 Amperes available, then it will charge the batteries at this 55 Ampere rate. If the battery is a 100 Ampere-hour battery, then the C/10 rate for this battery is 10 Amperes. The 55 Amperes from the source would recharge the 100 Ampere-hour battery at a rate over five times faster than it should be charged. This will result in premature battery failure, higher operating costs, and much lower system efficiency.



Above: The engine powering this generator is a Honda G40 model displacing 170 cc with a rated output of 4.5 horsepower. This particular engine has outlived four alternators and now powers a 100 Ampere Chrysler alternator. I estimate that this engine has run over 13,000 hours in the last fifteen years. It still has its original valves and piston rings.



Right: Proper pulley alignment is essential for efficiency and long belt life. This particular generator would produce 60 Amperes of current for five hours while consuming about ¾ of a gallon of gasoline.

Constant Current

Constant current charging means that the batteries are recharged at a fixed amperage rate until they are full. The voltage of the batteries is left unregulated until the batteries are full. The rate of charge is usually between C/10 and C/20. Constant current charging assures that the batteries are not charged too rapidly. Rates of charge greater than C/10 produce heat which can warp the thick plates of deep cycle batteries. Too rapid recharging wastes energy in heat and hydrolysis, and gradually ruins the batteries.

Engine-driven Power Plants

The engine-driven source has the distinct advantages of delivering large amounts of power when you need it. This is very different from wind and solar systems, where you have to take it when you can get it. Its major disadvantage is that it requires fuel and maintenance. Engines do not usually suffer from being undersized. If the power source is capable of delivering between C/20 and C/10 rates of charge to the batteries, then the system is happy.

Lawnmower Engines and Car Alternators

The idea here is to use a lawnmower engine (or any other small horizontal shaft engine) to drive an automotive alternator. The alternator puts out between 35 and 200 Amperes (depending on its size) of 12 to 16 Volt DC power to recharge the batteries. The first engine we used actually came from an old lawnmower we bought for $35. We got a 35 Ampere Delco alternator from a dead Chevy in the junkyard for $15. We bolted the entire works to a thick wood slab, and used an old oven heating element as a crude resistive field controller. The unit ran and charged our 350 Ampere-hour battery for two years before the engine died.

Type and Size of Engine

We've since tried many different combinations of engines and alternators. Small gas engines between 3 and 8 horsepower work well. We found that the Honda small engines will run more than 5,000 hours without major work, Tecumseh engines about 800 hours, and Briggs & Stratton engines about 600 hours. The particular Honda G40 (170 cc, ≈4.5 hp) engine pictured here has run for over 13,000 hours with the same rings, bearings and valves. The Honda also has the advantage of a 100 hour oil change interval, compared with 25 hours for both the Tecumseh and the Briggs & Stratton. If you consider the operating life and operating cost of small engines, then the higher quality engines are much less expensive despite their higher initial cost. The engine's size is determined by the size

of the alternator. This assures a balance between system efficiency and cost. A 35 Ampere alternator can be driven by a 3 hp engine. A 100 Ampere alternator needs at least a 5 hp engine. For alternators between 100 and 200 Amperes use the 8–12 hp engine. See Access at the end of this article for a source of small gasoline engines.

Type and Size of Alternator

Just about any automotive alternator will work in these systems. What really counts is the size of the alternator. Its current output (amperage rating) should be sized to match the capacity of the battery pack. The more capacity the battery pack has, the bigger the alternator must be. The alternator must be able to deliver at least a C/20 rate of charge to the batteries. We have had good results with 35 Ampere Delco alternators for battery packs under 700 Ampere-hours. Batteries up to 1,400 Ampere-hours are fed with the 100 Ampere Chrysler alternators. Packs larger than 1,400 Ampere-hours should have a 200 Ampere rated alternator. The higher amperage alternators are measurably more efficient than the smaller ones.

The higher amperage alternators are more difficult to find. Try your local auto electric shops, they may have a source for these high amp jewels. Regular alternators up to 70 Amperes are usually available from junkyards at less than $20. Alternator rebuilders can provide rebuilt units (new bearings and brushes) from $40 to $150. These alternators are a good investment. They are designed to run under the hood of a hot car on a summer day. In the type of service we give them, they run cool and last a very long time. I've seen these alternators last over 10 years with just the replacement of bearings and brushes.

The more modern alternators contain their voltage regulators within the alternator's case. These internal regulators need to be disabled and/or removed before these alternators are useful in this system. If you can't do this yourself, then take the alternator to an alternator shop for help. Some alternators have what is known as an "isolated field". These need to have one field connection grounded to the alternator's case and simply feed positive energy to the other field connection. The older Delco types are very simple and straightforward to use. They require no modification. Every alternator is a little different, so if you're not sure what you have, then go to the library and look it up in an automotive manual.

Getting it all together — Assembly

We originally bolted both the alternator and the engine to a wooden slab about 16 inches by 24 inches and 4 inches thick. Be very careful with engine and alternator pulley alignment. If the engine pulley and the alternator pulley are not properly aligned (in the same plane), then the unit will wear belts out very rapidly. These engine/alternator combos work best on heavy metal bases. There is a lot of vibration and the wooden slabs give up after a few years. Either add a sheet of 1/4 inch to 3/8 inch thick steel between the wood and the engine/alternator, or make the base completely out of metal. A local welding shop made us a base out of 3/8 inch thick steel plate with a welded one inch by two inch steel square tubing perimeter for $50. You can see it in the photograph. If you can weld, the materials cost about $18. Use heavy bolts with lock washers to secure everything to the base.

We coupled the alternator to the engine with an "A" sized Vee belt. Keep the belt length to a minimum by mounting the engine and alternator close together. We use belts between 28 and 33 inches in total length. The stock pulley on the alternator works well. The best sized engine pulley is between five and six inches in diameter. This pulley ratio gears up the alternator for better efficiency while allowing the engine to run about 2,200 rpm. We have had very poor results with the lightweight cast aluminum pulleys or any pulley using set screws. These light pulleys were not up to the high vibration job and broke frequently. We're now using cast and machined iron pulleys (such as the Woods brand SDS pulleys) that work very well and are extremely rugged. These are available from power transmission product stores and cost about $40.

Be sure to get the alternator turning in the right direction. Electrically it makes no difference, but the alternator's fan is designed to suck air from the back of the alternator and to exhaust this air in front around the pulley. If the alternator's fan is running backwards then the alternator will overheat when heavily loaded.

Use large wire to hook up the output of the alternator. Something between 6 gauge and 0 gauge is fine, depending on the length of the runs. Locate the engine/alternator as close as possible to the batteries. This keeps power loss in the wiring to a minimum.

Control Systems

The very first engine-driven charger we built worked fine, but we had problems controlling it. We were using a standard car voltage regulator. It wanted to charge the batteries far too quickly and the large load often stalled the engine. We experimented with many forms of control and found two which work well.

Alternator controls work by limiting the amount of power supplied to the alternator's rotating magnetic field. All alternator control starts with controlling this magnetic field's energy.

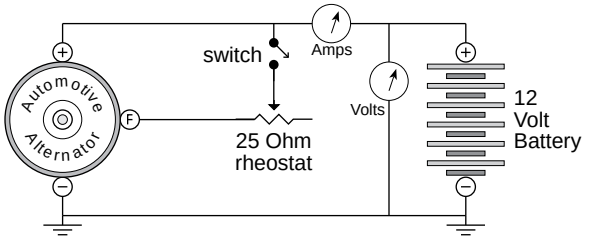
Car Voltage Regulators

Car voltage regulators will not work well in deep cycle applications. The regulator makes its decisions based only on the system's voltage. This is fine with the average car battery which is cycled to less than 1% of its capacity before being refilled. However, the deep cycle battery is almost empty when it is recharged. The car voltage regulator attempts to instantly bring the system's voltage to 14–15 Volts. A 12 Volt deep cycle lead-acid battery will not reach a voltage of 14 Volts until it is almost filled. The net result is that the car regulator dumps the entire output of the alternator into the batteries until they are full. This is almost always too much energy too fast for a fully discharged battery.

To compound the problem, the car regulator's voltage limit is set too low for deep cycle service. This low voltage limit means that the batteries are charged too slowly when they are almost full, resulting in many extra hours of generator operation to totally fill the battery pack. Since the car regulator is set at about 14 Volts, we are unable to raise the system voltage up to over 16 Volts for the essential equalizing charges.

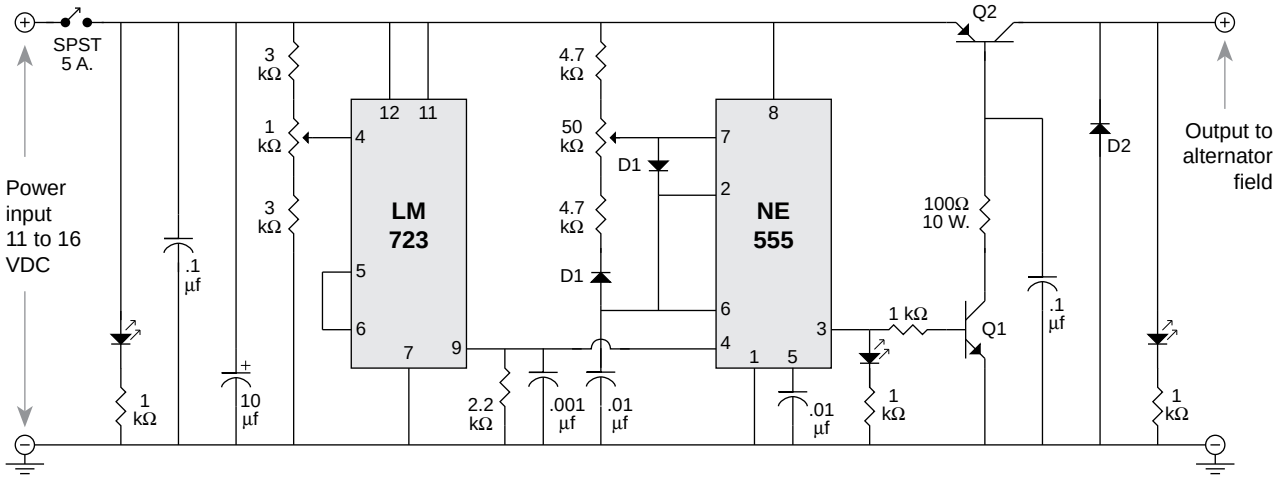
Resistive Field Controller

The simplest control for the alternator is resistance to limit the power to the alternator's field. The idea is simple: insert resistance between the battery's positive pole and the alternator's field. This controls the intensity of the alternator's electromagnetic field and thereby its power output. Resistance of 2 to 25 Ohms works well. Adjust the resistance until the charge rate is between C/20 and C/10. The less resistance in the field line, the higher the amperage output of the alternator. Originally, we used a nichrome wire heating element from an old electric stove. We selected more or less wire (hence more or less resistance) with an alligator clip lead. It worked fine. A better resistor is a 0 to 25 Ohm rheostat (adjustable power resistor) rated at least 25 Watts. This allows smooth adjustment of the alternator's output. The illustration above shows the wiring hookup for a resistive field controller. The switch shown in this circuit needs to handle about 5 Amperes and prevents energizing of the field when the charger is not in use. See Access for a rheostat source.



A resistive field controller.

Electronic Field Controller version 8.3



Field Controller version 8.3 — Parts Notes

Integrated Circuits

LM723 Voltage Regulator, in 14 pin DIP

NE555 Timer, in 8 pin DIP

Transistors

Q1- 2N2222A or eqiv. NPN

Q2- MJE 2955, or any PNP with Ic>5 Amps., heatsunk

Diodes

D1- 1N914 or equivalent

D2- 1N1202A, or any 3+ Ampere diode, heatsunk

All resistors 1/4 Watt & 5% unless otherwise noted

All capacitors are 25 Volt rated

Using resistive field control only regulates current. The resistive circuit does not provide any form of voltage regulation. When the batteries are full the system voltage can get high, over 16 Volts. Voltage this high can damage 12 VDC appliances. The highest voltage for most 12 Volt equipment is around 15 Volts. If you are using resistive field control, be sure to monitor the system's voltage and reduce the current output of the alternator to keep the system voltage under 15 Volts when appliances are being used.

Electronic Field Controller

We eventually solved the problem of control by designing electronic field controllers that regulate both the amperage and the voltage of the alternator. With this electronic field control, we simply set the desired charge rate, and set the system's voltage ceiling. The battery is recharged at a constant rate until it is full. When the batteries are full, the voltage limit predominates and the system is voltage regulated, thereby protecting the batteries from overcharging. And also protecting all electrical equipment on line. The amperage output is adjustable from 0 to the full rated output of the alternator. The voltage limit is adjustable from 13.5 Volts to 16.5 Volts.

For the intrepid electronic builder, this electronic field controller's schematic is included on page 31. It uses off-the-shelf parts available at Radio Shack or any electronics supply store.

Engines for Equalizing Charges

This engine-driven source is a good type to use for the equalizing charges and whenever the RE sources are not keeping up with the system's energy consumption. Its voltage output is capable of being adjusted to over 16 Volts in order to accomplish the equalizing charge. The engine-driven source is capable of delivering a C/20 rate of charge for the at least five continuous hours necessary for battery equalization. Remember the batteries must already be full before the equalizing charge is started.

Access

Author: Richard Perez, c/o Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179

Engines: Northern Hydraulics, PO Box 1219, Burnsville, MN 55337 • 800-533-5545 • 612-894-9510

Rheostats and surplus meters: Fair Radio Sales, PO Box 1105, Lima, OH 45802 • 419-223-2196

Kyocera

camera ready
balck and white
4.6 inches wide
7.4 inches high

carryover from HP#41

Hydro Basics

John Cowdrey

Hydroelectric power potential depends of the basic physics of falling water. While the concepts of head, flow, and pressure may seem esoteric, they are actually simple.

Where does the water pressure come from?
Pressure is generated by the weight of water due to a difference in elevation. Figure 1 shows that the 62.4 pound weight of a cubic foot of water exerts 0.433 pounds of pressure on one square inch. This means that for every foot of elevation, the static pressure increases 0.433 pounds per square inch (psi). Another way of saying this is that for every 2.31 feet of elevation, the static pressure increases one psi.

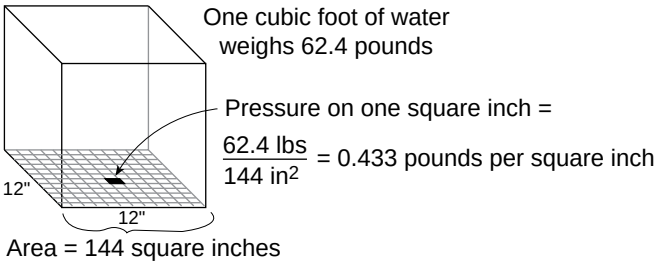


Figure 1: Each foot of elevation gives 0.433 psi pressure

Pressure and flow
Static pressure means the pressure when no water is flowing. From the previous section, you can see that 100 feet of elevation will produce a pressure of 100 feet x 0.433 psi/ft or 43.3 psi.

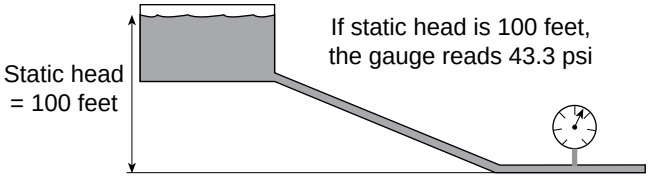


Figure 2: Static pressure

When water begins to flow, there is some friction between the water and the wall of the pipe, which reduces the available pressure. Flow in a pipe is designated by the letter Q. As shown in Figure 3, flow equals cross sectional area times velocity, or Q = A x V.

$$Q = A \times V$$

Flow = cross sectional Area x Velocity

$$\frac{Ft^3}{Sec} = Ft^2 \times \frac{Ft}{Sec}$$

Figure 3: Flow

For a given flow, the equation can be written V = Q/A which means that the velocity is inversely proportional to the cross-sectional area A of the pipe. Figure 4 shows that for a given flow, the velocity of water in a pipe is inversely proportional to the square of the pipe diameter. This means that the friction losses rise dramatically as the pipe diameter is reduced because the velocity increases four times when the pipe diameter is reduced by half.

If the pipe diameter is reduced by half,
the velocity increases four times

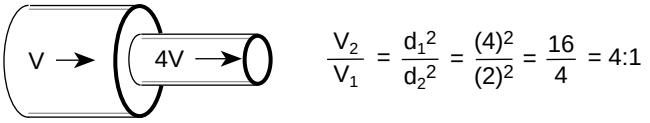


Figure 4: Velocity vs. pipe diameter

If the pipe is undersized, this friction loss can be substantial, and the available pressure is reduced. Another way of expressing potential hydraulic energy is by using the term “head”. Static head is the difference in elevation between the reservoir and the turbine. Friction losses cause loss of head over a length of pipe, making it appear that the reservoir is lower than it really is when the water is flowing, as shown in Figure 5.

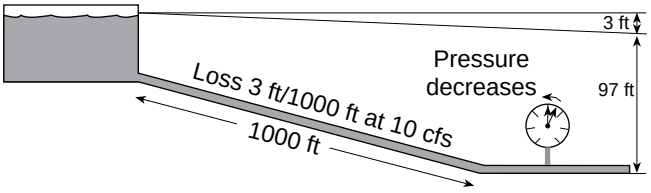


Figure 5: Loss of head (pressure) due to flow of water

Pressure head and velocity head
Besides the fluid energy due to pressure, water has energy due to its velocity, or kinetic energy. This is expressed in Bernoulli’s equation, which is studied in the field of fluid dynamics. The point we need to make here is that there is water energy due to both pressure and flow. It is convenient to express the velocity energy in feet of head, which is called velocity head. Mathematically, the velocity head is: V2/64.4, where V is the velocity of the water in cfs. One type of turbine works better on high pressure, and one is better for higher flow applications, as is discussed below.

Two types of turbines — impulse (Pelton) and reaction (Francis)

There are two classes of turbines: impulse and reaction. A Pelton wheel, shown in Figure 6 is an example of an impulse turbine. This type of turbine is useful in applications where there is high pressure and relatively low flow. The water flow is controlled by one or more needle valves, which direct the water into buckets on a wheel or runner. As the water strikes the buckets, all of the head is converted to velocity head, and the water velocity is reduced almost to zero, which spins the runner. The water falls out of the buckets and through an air gap into a tailrace, where it flows from there by gravity.

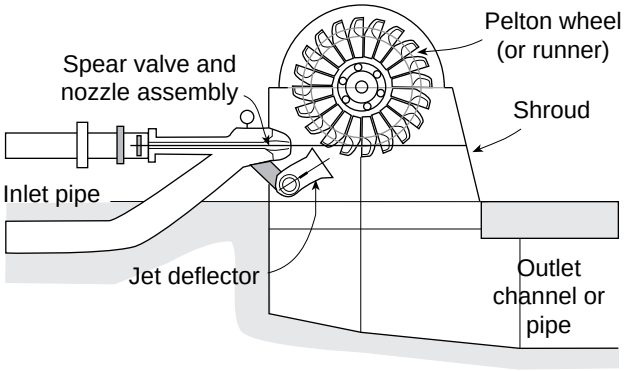


Figure 6: Typical Pelton wheel turbine

The Pelton turbine diagram also shows a deflector. It has two purposes. The first one is to deflect water away from the runner buckets during an emergency shutdown. Such a condition might arise when the electrical generator trips off-line due to a power outage. This trip removes the load or restraint on the turbine-generator, causing it to overspeed. We want to limit this overspeed since it stresses the equipment. However, if the needle valves are closed too quickly, pressure can increase to unacceptable levels upstream due to changing the momentum of the water in the pipeline. In this case, the deflector moves between the needle and the runner, deflecting the water into the tailrace as the needles close at a rate slow enough to avoid water hammer. The second use for the deflector is to match the generator speed and phase to the utility system before the circuit breaker is closed to connect the generator to the utility. This process is called synchronization.

A Francis turbine, shown cross-section in Figure 7 is an example of a reaction turbine. The water passes through a snail-shaped scroll case, through wicket gates that control the amount of water, and into the runner. The runner, which is totally submerged, changes the momentum of the water, which produces a reaction in the turbine.

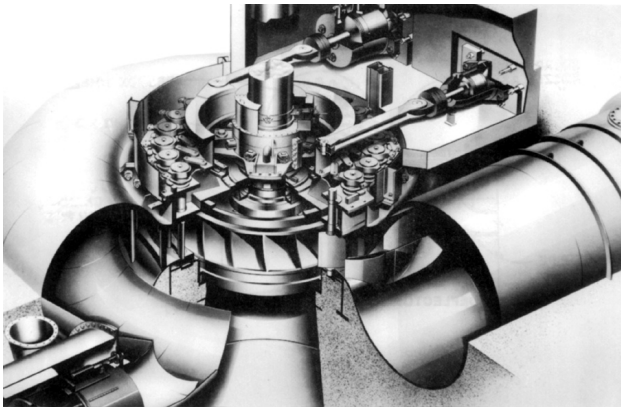


Figure 7: Cross-sectional view of a horizontal Francis turbine.

With a Francis turbine, downstream pressure can be above zero. Precautions must be taken against water hammer with this type of turbine. Under the emergency stop, the turbine overspeeds. One would think that more water is going through the turbine than before the trip occurred since the turbine is spinning faster. However, the turbine has been designed to work efficiently at the design speed, so less water actually flows through the turbine during overspeed. Pressure relief valves are added to prevent water hammer due to the abrupt change of flow. Besides limiting pressure rise, the pressure relief valve prevents the water hammer from stirring up sediment in the pipes.

Electrical generation basics

The way we generate electricity is to spin a magnet inside a coil of wire such that the magnetic lines of force are cut by the coil. Magnetic theory teaches us that a voltage is induced into the stationary coil (stator). We can make the magnet in two different ways. In a synchronous generator, some of the generator's output power is fed into the rotating coil (rotor) via slip rings to make an electromagnet which can be precisely controlled. An induction generator is just an induction motor, where the magnet is induced into the rotor from the stator. Normally, an induction motor runs slower than the electrical system speed and absorbs power. If we drive the induction machine faster than the system speed with our turbine, power flows into the system.

With either generator type, alternating current (ac) voltage is produced. When the rotor poles are adjacent to the stator coil, maximum voltage is induced since the most magnetic lines of force are being cut by the stator coil. When the rotor is perpendicular to the stator, no magnetic lines of force are being cut, and voltage is zero at that instant. As the rotor continues to revolve, the north and south poles of the rotor are reversed from the previous condition, and maximum voltage is induced in the opposite direction.

Large power projects generate/distribute three phase power. There are usually three stator coils spaced 120 mechanical degrees apart. This produces three single-phase voltage waveforms which are 120 electrical degrees apart. This is called three phase power.

Synchronous generators are more complex, costly and harder to synchronize, but are more efficient, produce a better quality power, and are used for larger units. Induction generators are simpler, less expensive, and are used for smaller units.

Efficiency

In a turbine generator, there are mechanical losses in the turbine, and mechanical and electrical losses in the generator. The generator losses include copper losses due to the heating of the wire, power required to form the rotor field, and mechanical losses such as friction and windage (some force is required to move cooling air through the generator). If we compare the hydraulic energy into the turbine with the electrical power produced, we can expect a water-to-wire efficiency of about 50% to 90% depending on turbine size.

Access

John Cowdrey, 3746 El Dorado Springs Dr., Boulder, CO 80303 • 303-441-3245

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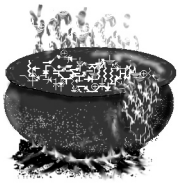
How to Build a 1.5 kW, 24 VDC Wind Generator



Homebrew

or ***how not to put Bergey out of business!***

Dick Linn

This is the story of my latest wind power project. In Feb of 1990, I put up my first wind generator based on an old water pumping windmill. (see Home Power Dec/Jan 91) That first rig, with its max output of about 7 or 8 amps @24 VDC, told me there was wind potential at my site. It was also fun to watch, but short on output. So I set out to build a second system going for more power. I decided on an airfoil design, as the drag type blade on the water pumper is definitely limited in output.

The Tower

I started the project in earnest after talking to a fellow at the next booth at a broadcasters' trade show I was attending in Syracuse. He sold towers and had a 10 foot stub in his booth. I made a comment about how I could use that stub for my next windmill project, and one thing led to another. Come to find out, he had a 55 foot freestanding tower that he had pulled down and was willing to sell for $300. He figured that was the scrap value of it. I'd have to come to his place of business and pick it up. No problem! I finally did several months later, after I lined up a friend's flatbed farm wagon to haul it on. The tower was triangular, two 20 foot sections and one 15 foot section. Each section weighed about a ton! The legs were made of 2 & 3/8 inch diameter solid bar stock. We loaded it on the wagon with a crane and I pulled it home with the pickup. Have you ever followed a farm wagon down the highway as it weaves from side to side at 30 mph? That's why I did 25 mph all the way home! All 60 miles.

Above: The 1.5 kW. wind generator on a hill behind our barn's PV covered roof. Photo by Dick Linn

I had to disassemble the tower sections to get it off the wagon. I had no crane at home to lift it off! This tower is five foot to a side at the base and has no taper. I needed to bring the top to a point so that I had a place to mount the wind generator and provide clearance for the blades. On the the next part of the project.

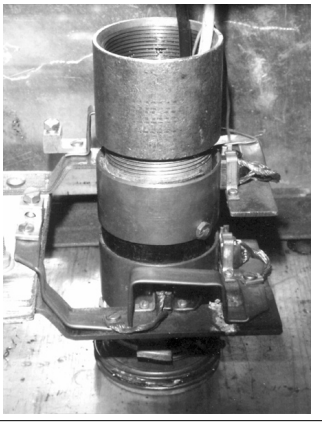
Tower Top

The nice part about these home-built projects are that they broaden your horizons. They're a learning experience. The next step for me was learning to weld! So I signed up at the local Adult Ed evening classes for "advanced welding". I know how to braze so I hoped that I could jump in and keep up in the advanced class. I was able to take the class for free as I teach a motorcycle education class through the same Adult Ed program. The instructor was great. I basically built the tower top in class. I had to do it in class as I don't have a welder at home. I then pieced the tower top together in my barn. I have a 2 story pole barn with one 8 x 10 foot portion that's open floor to ceiling. It's where the elevator is going to go to lift bikes upstairs, when I ever get it built! Anyway, the tower top went together in the barn as I finished parts in class. I even mounted the generator, blades and tail on the top while in the barn. I couldn't rotate the blade fully though, as it hit the roof beams. But I was able to test fit everything inside while I was sitting on the second floor of the barn, rather than 60 feet in the air. The tower top added about 10 feet to the tower's height. The legs were made of 3/16 inch X 2 inch X 10 foot angle iron. The top of the tower is a 3

legged tripod with a piece of 4 inch pipe about 30 inches long down through the center. The pipe has roller bearings at the top and bottom, (from the scrap yard, of course). These bearings support a piece of 2 3/8 inch pipe that has a flat steel plate welded to the top and is threaded on the other end. The plate holds the generator, the threaded end is where the slip ring thread on.

The Slip Rings

The slip rings are made from a copper pipe coupler. This I cut in half and used the 2 pieces to make the positive and negative rings. The rings were slipped over pieces of one inch plastic water pipe cut open and spread around a short piece of 2 3/8 inch pipe. I then drilled a hole through the copper, plastic, and iron pipe. I



sleeved a screw and used step fiber washers to insulate the screw from metal parts. On the inside of the iron pipe, I connected the lead wire from the generator to the screw. The screw thus conducts the current to the copper ring. To collect the current, I robbed the brushes and holders from a Ford starter. These I bolted to pieces of strap iron which were connected to a piece of wood to insulate them from the supporting framework. I flattened 3/8 inch copper pipe to use as current carrying conductors from the brushes to the tie point for the cable that carries the current to the tower base. I later had to substitute a piece of phenolic for the wood as the wood warped when it got damp.

The Tail

The tail is just a piece of 1/8 inch aluminum sheet bolted to an angle iron framework. This framework pivots on another framework bolted to the back of the railcar generator. The frame bolted to the generator has several holes drilled in it so that the tail may be adjusted to pivot at different angles from vertical. This was done as so I could try different angles for different fold out wind speeds. The angled pivot of the tail means that the tail not only swings to the side, it also must raise a small distance vertically. This means that gravity is tending to pull the tail down, keeping it straight behind the wind generator. The wind generator is trying to pivot out of the wind because it is mounted two inches off center with respect to the yaw bearing. Thus the wind is always trying to push the generator out of the wind, and the tail is resisting that push.

Up She Goes

I poured the footings for the tower in Feb 93. I think the temperature got up to +6°F that day. I didn't have any trouble renting a cement mixer! The footers are 7 feet deep by 2 feet in diameter. A fellow drilled them with an attachment that bolted to his back hoe. I took 2 3/8 inch pipe and welded 1 1/2 foot lengths of rebar to the sides of the pipe. I had also welded a flange to the end of the pipe to bolt the tower legs to. These pipes I set into the 3 holes in the ground. I built a template of plywood and 2 x 4 on the one section of tower that was still together. I used this template to line up the 3 pipes in their holes. I left it bolted to the pipes until after the concrete had set. The concrete I used was ready mixed in bags, just add water and serve! I beefed up the mix by adding more straight portland cement to the mix. The tower itself I put up 1 piece at a time. I couldn't afford a crane to come in and erect it, so I put up the 3 legs of the first section by hooking a wire cable between 2 nearby trees and using rope and pulleys to raise the legs. I then bolted up the cross braces between the legs. I now had a 20 foot tower. The next tier of legs I raised

using a “gin pole”. I made the gin pole from a tubular aluminum arm that had been a cross arm on a light pole. I picked it up at a scrap yard. I ran a cable from a hand cranked hoist to a pulley at the top of the pole then down to the leg to be raised. I tied the cable just above the midpoint of the leg as the gin pole wasn’t as tall as the leg. In fact I had to hook below the center of the leg on the 20 foot legs to be able to raise the leg high enough to set it in place. That required 3 ropes tied to the bottom flange of the leg to steady it as it was raised. My brother helped getting the first leg up. The others I did alone. The gin pole fit into 2 holders welded to plates that bolted to 2 x 10s. These were “U” bolted to the top 3 horizontal braces of the section in place. The gin pole had to be unbolted and moved into the proper place for each leg. The setup to lift a leg took more time than lifting the leg. The top pyramid section I was able to bolt into place without using the gin pole. I then mounted an “A” frame made from two 10 foot pieces of 2 inch angle iron that had a 2 foot arm at the top. This had a pulley at the end of the arm. I ran my cable over the pulley and then down to the generator on the ground. I clamped the hand cable hoist up in the tower and with the help of my brother on a guy line we lifted the 600 lb. generator up to the top of the plate on the yaw bearing. This was bolted into place with four 3/4 inch bolts using the original mounting holes on the generator.

The Generators

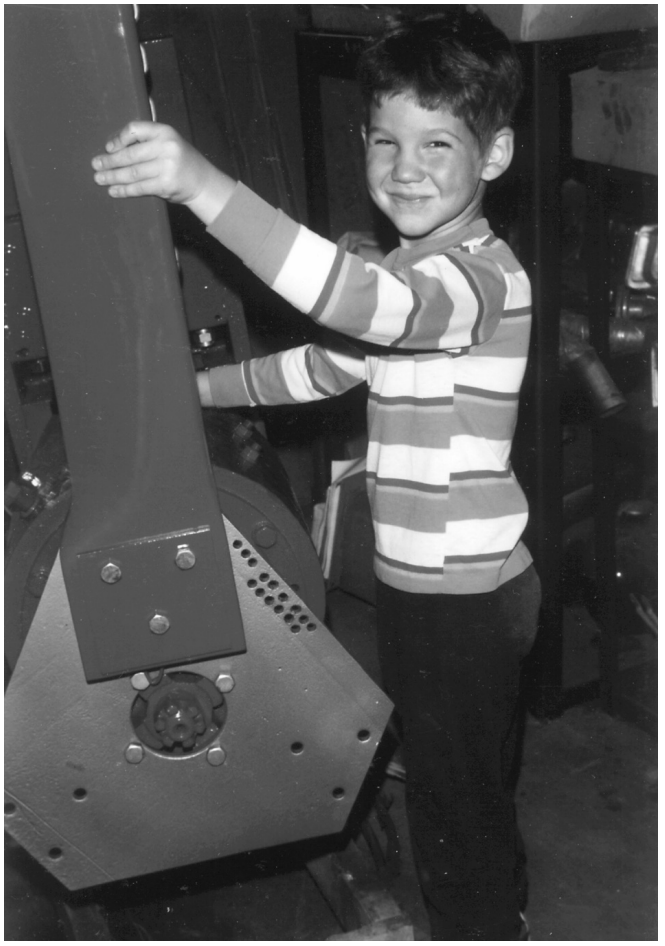
Yes, generators, plural. As usual with one of my projects it takes me forever to go from start to completion. This one was no different. I started out looking for a truck generator as described by Steve Hicks in an article in HP 12. I found one on a early 1950s Brockway truck belonging to a friend. It was an Autolite 12 VDC 50 A generator that weighed about 60 lbs. It reached rated output at about 1000 rpm. I decided to rewind it for higher output voltage as per Mick Sagrillo’s article in H.P. on rewinding. I did rewind the armature, which took awhile. Before I had finished the rewinding job, I stumbled across an even better prospect for my project. I had stopped to look over the rail cars used on an excursion train, one of those ride and dine affairs. I started looking at the equipment hanging off of the bottom of the car. There was this BIG round thing that looked a lot like a generator. It was. I crawled under the car, (it wasn’t hooked to an engine at the time) and checked it out. It was a 100 Amp 40 VDC generator rated at 500 rpm. Perfect says I. So I asked around and eventually talked to the fellow who did all the electrical work for the railroad. Seems they weren’t even using the generator. It wasn’t geared to work at the slow speeds that the excursion train travels. So we struck a deal, $100.00 for the generator, $50.00 for the voltage regulator/cutout. The generator was made by a company called Safety Industries. They may now be out of business since I couldn’t find any number for them. So I reworked my design around this new find. I hoped to be able to drive this generator with the blades mounted directly to the generator shaft. Which brings me to the blades.

The Blades

In March of 92 I ordered a set of semi-finished blades from Mick Sagrillo at Lake Michigan Wind and Sun. Mick has been a great help throughout this project, listening and giving advice freely. Anyway, the blades were 5 feet long, made from laminated Sitka spruce. He has a bunch of them, something about a deal with some entrepreneur for wind powered billboards that fell through, leaving Mick with a quantity of blades and no buyer. I bought 3 blades for $330.00, shipped. These I sanded down till smooth. I finished them with 3 coats of DuPont Imron as a primer and 3 coats of DuPont Centauri as finish coats. This was according to Mick’s suggestions. They certainly are shiny!

Blade Balancing

The blades I balanced by following the routine outlined by Mick in HP 14. I weighed each blade individually after they had been sanded smooth. I took the weight of the heaviest and figured roughly how much weight to add to the other two. I melted lead into a piece of 3/4 inch copper pipe and cut it into pucks about 5/8 inch thick. These I added to the lighter blades at a point where the wood was thickest along the chord of the blade, about a foot or so from the base. I had the blades mounted to the hub plate. I added weights to them until I had the blades balanced. I made my own balancing jig from a piece of steel plate with a pointed rod approximately 1 foot long welded to it. I made an aluminum center piece from an old VCR head that fit over the point. The blade hub plate center hole just fit into this center piece, and the center piece set on top of the pointed rod. I had balanced the hub plate first by drilling holes at the edge where it was heavier. After balancing the hub, I attached the blades. After finding how much weight to add to each blade, I drilled holes to hold the lead/copper pucks in the blades. I epoxied them in and then skimmed over the holes with “Bondo”. I then proceeded with painting the blades.



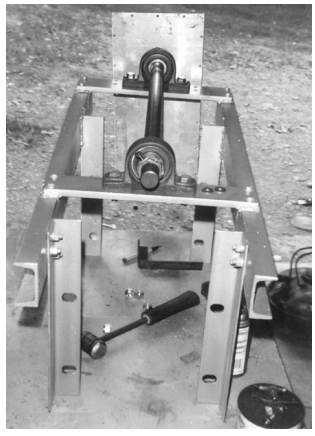
Above: Able assistant Tyler Linn demonstrates how the blades mount. Photo by Dick Linn

Those Designer Blues

These blades should be good for about 1.5 kilowatts of power at around 27 mph winds. My railcar generator is rated at 4 kW. So now I had more generator than blades to power it. I figured that the generator was rated at 500 rpm and the blades were good for about 360 rpm. So it seemed that the generator running at reduced speed might match the power capability of the blades. I tested the generator by driving it via the pulley that came mounted on it. This was designed for a flat belt. I backed a motorcycle rear tire against the pulley with the tire slightly raised off the ground and ran up some revs. The generator was connected to a 24 VDC battery bank via an ammeter and voila, I got some amps in the right direction. I wasn't too scientific about this experiment. All I wanted to do was be sure that the generator worked. I didn't try to get any rpm vs. output data. I should have! When I got the generator on top of the tower and the blades bolted to it and in the wind, I got no output. I tried applying power to the generator and I got the generator to motor. Also, when the wind was blowing and I hit the generator with voltage momentarily, I got one or two amps out from it. As soon as the wind died down a little, the output would drop off and not come back up. At this point I went back up the tower, pulled off the manufacturer's plate from the generator, and tried to read all the faded print on it. You see, this had been under a railroad car for 70 years and had been beaten up somewhat by the elements, ballast, dirt, etc. It wasn't easy to read. I finally decided that it must read "minimum rpm, 500". So I wasn't even getting close to the generator's power range. I then tried gearing up the drive to the generator with the blades on a separate shaft on pillow blocks and driving the generator via a chain and sprockets. I chose a ratio of 2.25 to 1 which would get the generator up to around 800-900 rpms. I hooked everything up and waited for some wind. And waited. And waited. The generator wouldn't turn at all. The blades were stalled by the mass of the generator armature and the extra shafting/gearing/bearing losses!

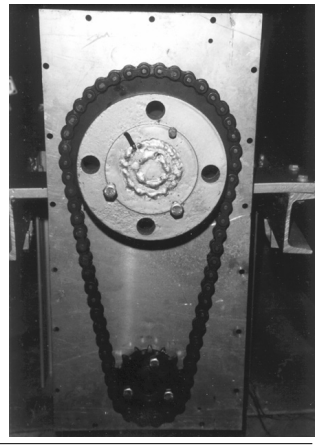
Plan Two

At this point as I was considering bigger blades and/or rewiring the generator armature, I remembered the Autolite armature that I had never finished rewinding. I was getting desperate as Fall was coming and I needed more power. We bought a SunFrost last Spring and had done ok for power during the summer, but the cloudy/windy season was fast approaching! I needed some power, now. So I dug out the armature and finished the rewire job and discovered "equipotential connections".



Back To The Autolite Generator

One of the reasons I had quit on the armature before was that it didn't test good when I had it growled. I had my friend at the auto parts store growl it before I had soldered down the windings to the commutator, just to catch any small problems before they became big ones. Only when he growled it, it tested full of shorts! (A growler is a test jig for armatures that uses ac current. It creates induced currents and thus magnetism in any shorted



windings in an armature.) I went through cleaning out between commutator segments and visual inspections several times and could not get rid of the shorts. That had been a year ago. So now I had it growled again to verify it still had shorts. It did. Then I did some reading in an old book from the 1920s on motor and generator rewinding (one of my yard sale finds). I found reference to "equipotential connections". It briefly mentioned that these are sometimes added to armatures to minimize arcing at the commutator. I knew that my commutator had these wires connecting every fourth segment with another segment 180 degrees opposite it on the commutator. So I lifted these interconnections and suddenly I had an armature that tested o.k. I then called up a motor rebuilding shop and the old timer in the back room said, "Yes, those connections will do that to you if you try to growl the armature, but the armature may still be o.k." So I put the generator together, made a brief test run driving it with my motorized DC charger (see HP 26 article), determined that it did work, and then had the motor shop "dip" the armature in the correct enamel and bake it. I then made a bracket that bolted to the bracket for the pillow bearings that bolted to the railcar generator to hold the autolite generator. I put a sprocket on the Autolite generator the easy way, I got lucky! The Autolite generator has a splined shaft with a big V-belt pulley on it. I had removed the pulley and tried to decide the best way to put on a sprocket. Then one night, in that half awake state, I visualized the sprocket from my wife's Harley Sportster and the splined shaft and thought, "They look the same." So I got up first thing that morning and went out to the barn to check it out with an old sprocket. Yep, the splines were the same. The sprocket fit! I kid you not. I tried the sprocket without modification but the generator turned too slowly. So I got out the torches, cut off the teeth, turned it down in the lathe and then went to "Central Tractor", the local farming accessories dealer. They carry an extensive line of sprockets with adaptor hubs to fit most any reasonably sized shaft. I'm told NAPA stores can also order these things. Anyway I got a smaller 13 tooth sprocket to give me an overall ratio of 1:3 speed increase. And It Works! I bought a wind speed indicator from Mick and came up with the following data: Cut in speed approx. 10 mph. Power @15 mph 10 amps @28 VDC Power @22 mph 25 amps @ 28 VDC Power @ 28 mph 45 amps @ 28 VDC. The tail starts pulling it out of the wind @ approx. 28–30 mph.

The Bottom Line

I've tried to include the costs incurred in building this project. I think I still came out ahead over the cost of buying a new unit, and of course I've had the "learning experience" and personal pride/pleasure from "doing it myself". The project isn't finished yet. I fully intend to get a set of bigger blades and drive the railcar generator, hopefully direct. But then that will probably mean an armature rewind. So, for this winter at least, I'm content to just watch that baby run! Last year, I ran my auxiliary charger 80 hours at a rate of 30 amps. To date, I have yet to start it, except for testing. So for the first time I have energy self sufficiency. A good feeling. The rest of my system is composed of a motley collection of used photovoltaic modules. Arco "muds", 16-2000s, and some Solec seconds, all charging a recycled, pocket-plate, ni-cad 24 VDC battery.

Homebrew Wind Generator Cost

Item	*Cost*	*%*
Blades	$330	21.6%
Tower 55 foot	$300	19.6%
70 bags of concrete	$247	16.2%
Tower (angle Iron, bolts, etc.)	$228	14.9%
Railcar Generator & regulator	$150	9.8%
Drilling foundation holes	$80	5.2%
Paint	$80	5.2%
Outside machine work	$55	3.6%
Ginpole	$40	2.6%
Armature dipping	$18	1.2%
Autolite truck generator	$0	0.0%
Total	$1,528	

Access

Author: Dick Linn, 3771 Morgan Road, Interlaken, NY 14847 • 507-532-9517

Tower: Tom Nudd, Fred A. Nudd Corp, Ontario, NY 14519 • 315-524-2531

Railcar generator: Tom Gasda, Tioga Central, (now defunct) Owego, NY

Blades: Mick Sagrillo,Lake Michigan Wind and Sun, 3971 E. Bluebird Road, Forestville WI 54213 • 414-837-2267

Autolite Truck Generator: My good friend Bill Fletcher, who collects old trucks.

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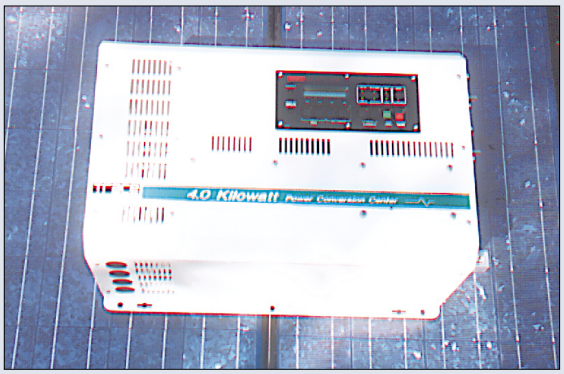

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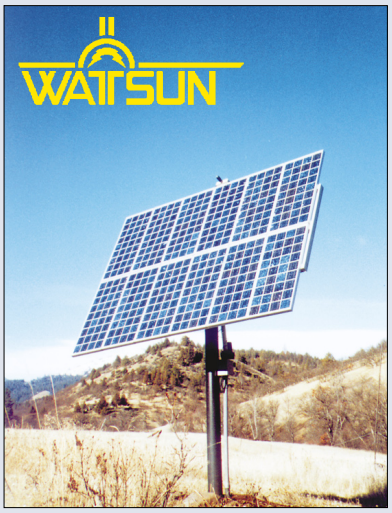

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Above: The Tropica, a sporty coupe designed from the ground up to be an EV, has an ABS body, twin EV drivetrains, and an estimated $12,000 price tag. Photo courtesy of Rennaissance Cars

EVs on Parade

Michael Hackleman

Just got home from the Felton Remembers Parade. Ah, yes, small towns. Ain't it grand! Everything that can roll, walk, or slide gets to make a one-way pass down Main Street. Horses and goats, fire trucks with kids piled high, slick old cars and Harley machines, and two electric vehicles.

Donna drove the Honda (its last parade, sniff sniff; the crusher beckons) and Karl Applegate drove the Electrathon the 7th and 8th grade students built, doing little figure eights in the roadway to the delight of the crowd, then speeding off to catch up with the parade. We worked long hours to get it ready (nothing quite like setting a milestone), and fixed all the things that didn't work from the initial test drives. In the parade, it performed flawlessly. No blown fuses, fried motors, or wheels falling off. It was well received, too. Thousands of people lined the street, many in lawn chairs. A celebration of life's little pleasures. A long walk on a sunny day with a lazy breeze.

The long-awaited technical review by CARB (California Air Resources Board) is over. Despite the testimony from auto company representatives over the difficulties that EVs impose on their lives and agendas, a massive demonstration of support came from many quarters at the mid-May meeting. The result? CARB is reaffirming its commitment to the mandate for 2% ZEVs (zero emission vehicles) by 1998. That's a 40,000-car market in California alone. Country wide, with other states jumping on the bandwagon, anybody that sells a snappy little electric is probably going to do well.

Speaking of snappy, Bob Beaumont, of Citicar fame, appears to have found the recipe for a fun runabout he plans to build in Florida and sell through dealerships throughout the country. The March 1994 Car and Driver Preview Test, the original Electric Car Skeptics Quarterly, gives the Tropica two thumbs up. They claim that because the car doesn't promise much, and delivers a little more, that it's a winner. At 2,200 pounds (Bob says he'll shave it to 1,800 pounds in production), it's pretty light for the twelve 6 Volt batteries in the pack. The ABS body avoids fiberglass usage. To get around the bottleneck of today's electronic controllers

(with their 400-Amp limiting) and to eliminate a transmission and differential, the Tropica design uses *two* independent drive trains — motors, controllers, and fixed-ratio belt drives. Very clever. The low pack voltage (72 V) keeps the offline leap to a chirp and eliminates a jackshaft, but can deliver power at 800 Amps to the rear wheels (50 hp minimum) for heady acceleration up to cruising speed. A classy sports car body design by Jim Muir will make the low $12,000 price tag seem affordable to a lot of folks. The lack of a roof frees Bob from having to meet many regulations (windshield glass, strong roof structure, etc.), which I'm certain will be available as aftermarket items. It's a savvy design worthy of study by anyone who is thinking of making EVs for sale. I hope I get to test drive one soon.

In this issue's GoPower section, Gail Lucas describes what it's like to drive an earlier Bob Beaumont creation, the Citicar. Tom Bennett, in "The SunCoaster Project", fills us in on an ongoing solar EV project at Lewis and Clark College. And, folks interested in simpler EV controls, will appreciate "Dynamic Braking in Simple EVs", a companion work to my article in HP#39.

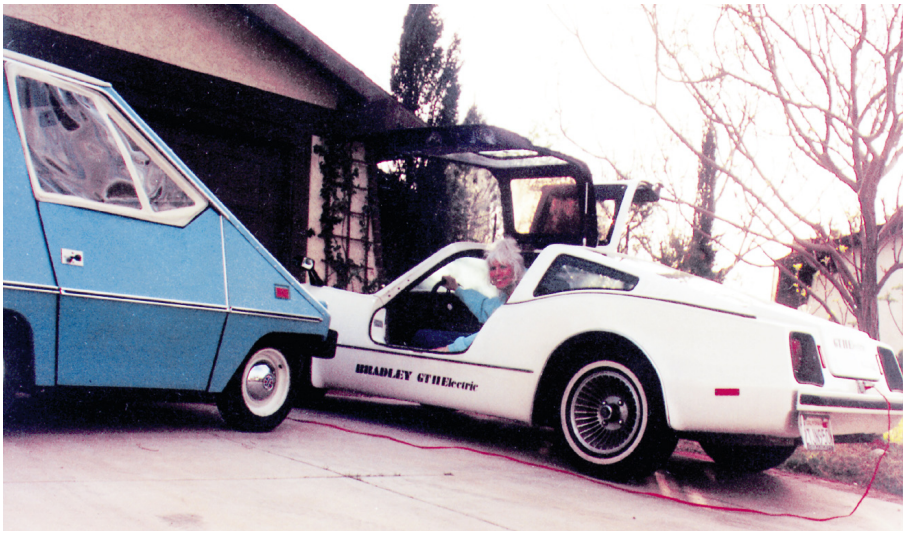
I'm in the middle of a move, still keying away at my EV book. Thank you for all your letters and kudos on GoPower. This is a job I love to do.

Access
Michael Hackleman, PO Box 63, Ben Lomond, CA 95005

Above: Michael Hackleman and Donna Worden take a break as the Honda gets a fillup from the sun between demo rides at the Tehachapi Wind Fair, 1993.
Photo by Jim Meurer

Driving the Citicar

Gail Lucas



Above: Gail Lucas behind the wheel of her Bradley GT Electric. Parked to the left is her Citicar.

As the owner of six electric vehicles, I promote the use of EVs to help get Las Vegas off the list of cities with the worst carbon monoxide levels in the country. I am an EV driver with no interest in going 80–90 mph, nor do I care how quickly I can accelerate from 0 to 60. Besides the safety factor, it's time to stop basing our social status on how fast our vehicles can go, and value cars for what they are: a means to travel from point to point.

Since I began driving EVs, I have not maintained, or needed, a gasoline powered car. I do not miss the possibility of spilled antifreeze poisoning my pets, the smell of noxious gasoline fumes, and dirty oil spots on the cement. Nor do I feel deprived when I go a whole summer without a radiator boiling over, or chatting with mechanics about which hose is about to fail. I do not feel discriminated against when I am not asked to get a smog check before I can pay my annual license fees. I gave away my old 11 mpg luxury vehicle and would not even consider the purchase of another gasoline powered car. If I need to drive across country, it will be much more convenient and cost effective to rent a car for the trip.

The 1976 Citicar is my favorite EV. It is not perfect, but is ideal for 40 to 50 miles of city commuting. It cruises at 35 to 38 mph, when the traffic allows me to go that fast. I can use parking spaces which are too small for other cars to use. In Las Vegas summers, with 110 to 114 degree temperatures, the removable windows and the plastic body are preferred to enclosed spaces and heat-retaining metal.

The eight 6 Volt batteries and one 12 Volt I added to the Citicar for the lights are very easy to access for maintenance. When it's time for replacement, the set will cost half as much as the 16–24 batteries needed in most converted cars.

A friend and I take the Citicar grocery shopping. I often purchase a 50 pound sack of bird seed and there's room behind the seat for it AND groceries for a week. I can tell at a glance before I open the door that no one is lurking in my car, an important consideration for a woman in Las Vegas. I doubt that anyone could hijack my Citicar.

I have passed gas-powered cars stalled in the flooded streets. I was rear-ended by a mid-sized American sedan and, although noisy, absolutely no damage was done. The car is very light and easily rolled; I believe that it just bounced forward when bumped.

I have to be sure the emergency brake is pulled tight when I take this car to school displays. Elementary grade children have caused it to roll by leaning on it. This is at times a desirable feature. I can move the car around the driveway without looking for the keys. Or push it out of the way in the event of a problem on the road. I once had a battery post melt-down. Another time, I burned up a fuse in the relay system. I have since upgraded the control system to a PMC controller, and have no problems along this line.

These are adorable, wonderfully maneuverable little cars, many of which are on the road seventeen years after they were built. Only an EV driver realizes the good public relations a Citicar promotes when driven. Smiles, waves and thumbs-up signs abound from other drivers, children and pedestrians.

It was referred to as “awesome” by two children of about 10 years as they observed me stopped for a light. I have been asked many times if it is the “car of the future.” I find notes on my Citicar windshield asking where one can be purchased, and phone numbers with requests to call with any information I have on them. Fortunately, a Citicar look-alike, the Kewet, is available at dealerships scattered around the country.

I hope the auto manufacturers will realize that the electric vehicle advantages — no pollution, little maintenance, and convenient, economical refueling — are more important to many people than high speed and cross country travel.

Access

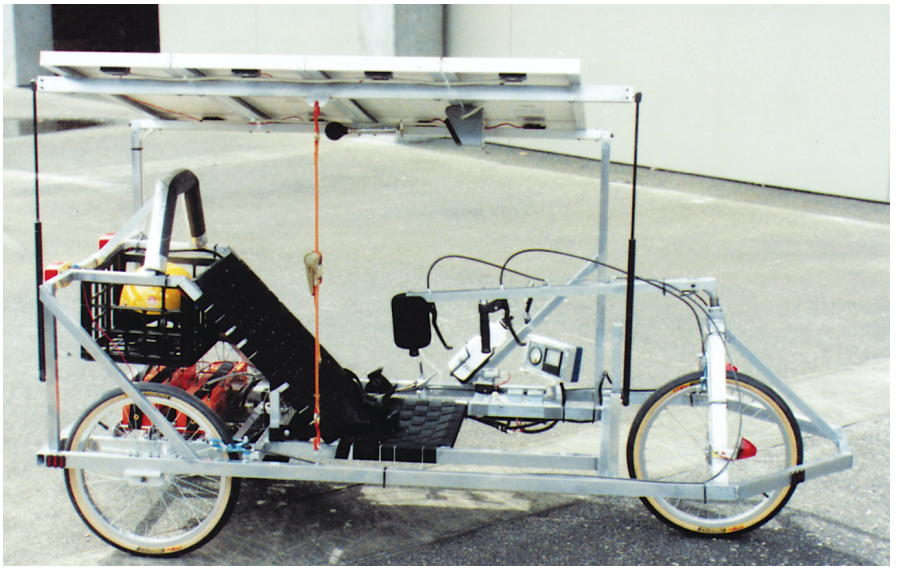
Gail Lucas, EVA-Nevada, PO Box 19040, Las Vegas, NV 89132-0040 • 702-594-9798. Gail Lucas is the president of the Las Vegas Chapter of the EAA (Electric Auto Association). The Desert Research Institute Library, which provides a permanent location for the club, houses the EAA collection of EV books, magazine articles, electric parts catalogs, conversion instructions and newsletters, available to members and the general public.

Above: Gail shows off her EV at a public event.

The SunCoaster Project

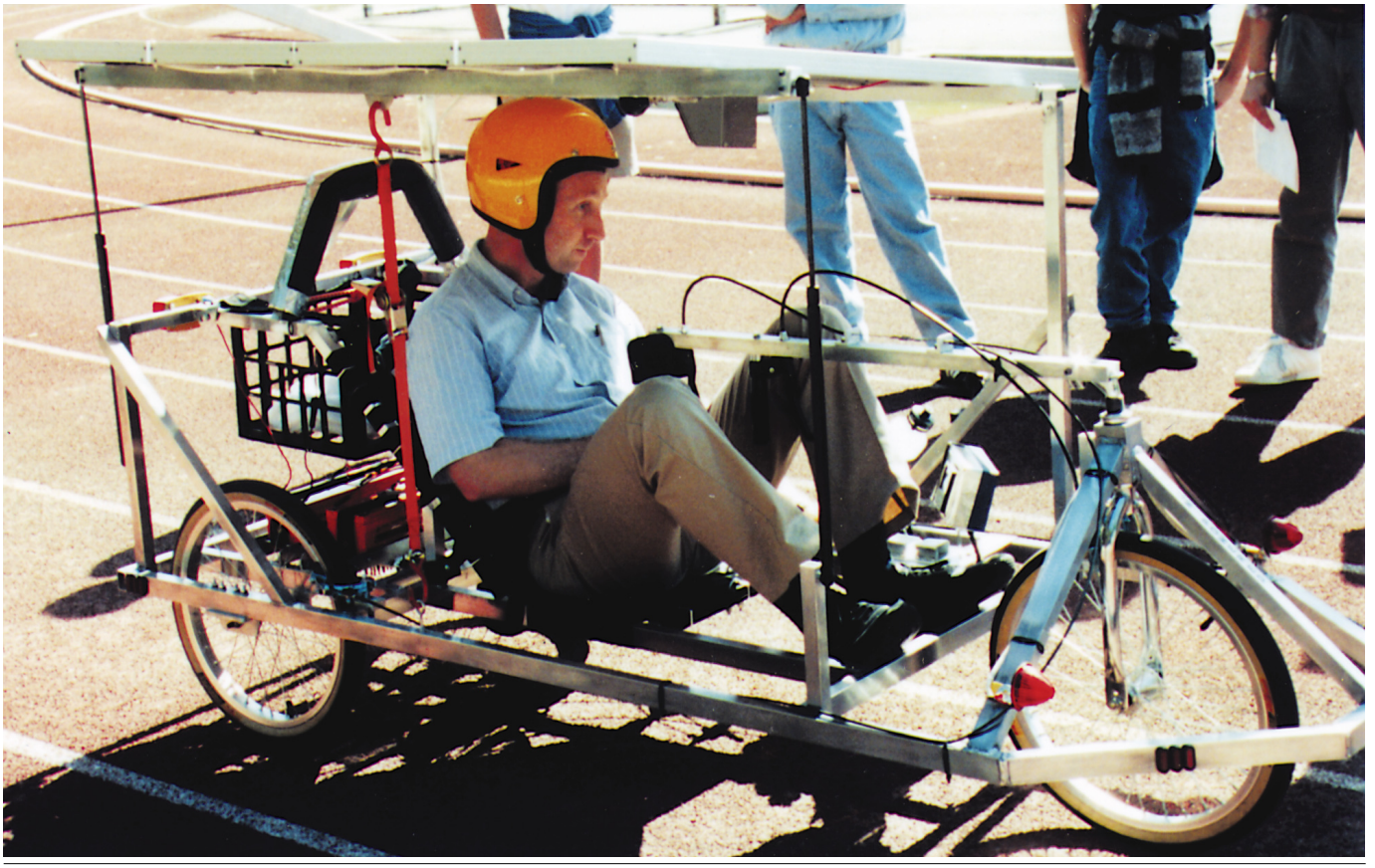
Tom Bennett

What has four wheels, can carry 220 pounds of driver and baggage, has a top speed of 19 mph, and gets the electric energy equivalent of 2,667 miles per gallon of gasoline? **SunCoaster**.



Origins of the Project

In 1990, some of my students and I visited the Siemens solar cell production plant in Vancouver, Washington. We saw processes for making solar cells and met the people involved. I arrange field trips to add flavor to the General Physics labs I conduct at Lewis and Clark College. The visit generated a lot of discussion about solar energy on the trip back in the van. Wouldn't it be great to build a solar car? That was the start of the SunCoaster project.



Two of my students and I submitted a solar car proposal that was funded by the Student Academic Affairs Board of Lewis and Clark for $2,250 to be built in the summer of 1991. One of these students graduated and left the project, so Eileen Niedermann and myself proceeded. We visited Western Washington University and were inspired by the projects involving Michael and Eileen Seal.

While we were gathering information for our design, we modified a go-cart frame as a test platform for our growing collection of possible electrical parts. It was unsafe at any speed but a necessary learning experience for our solar vehicle.

Construction Begins

Eileen and I attended SEER '91. We thoroughly enjoyed our Willits visit and came back loaded with notes, photos, product information, and contacts. An after-dinner sketch on a napkin looks remarkably similar to our final design! When we got back, we transferred this design to chalk on the floor, and then to the table trace. We kept the width and length of the vehicle to something that would fit inside a pickup truck for transport purposes. We bought our aluminum frame material and machined it to fit the worktable trace. An early contact, Don Holmboe of CMC in Tigard, Oregon did all the custom welding in his go-kart racing shop.

Gasoline-to-Electric Equivalents

Here's a handy formula for converting mpg (miles per gallon of gasoline) to W-h (watt-hour) per mile:

$$(\#)\ \frac{\text{Watt-hours}}{\text{mile}} = \frac{4.0 \times 10^4\ \text{Watt-hour/gallon}}{(x)\ \text{miles/gallon}}$$

Plug x number of miles per gallon to get the number of watt-hours. An electric vehicle that has a performance value of 50 Watt-hours per mile, such as the Horlacher electric (see GoPower, HP#41), gets the equivalent of 800 miles per gallon.

Here's the derivation of the formula:

$$\text{Gasoline (energy content)} = \frac{4.78 \times 10^4\ \text{Joules}}{\text{gram}}$$

$$\text{Density (gas)} = \frac{815\ \text{gram}}{\text{liter}}$$

1 gallon = 3.785 liters

1 gallon gasoline (energy content) = 1.47×10^8 Joules

$$\text{Watt-hours} = \frac{1\ \text{Joule}}{\text{second}} \times \frac{3600\ \text{seconds}}{\text{hour}} = 3600\ \text{Joules}$$

Watt-hours = 4.0×10^4 Watt-hours/gallon

We fitted components to the welded frame, including two solar panels we had purchased. We sent a photo of the vehicle to Siemens and they generously donated the remaining two panels we needed for the SunCoaster's power source.

While Eileen began her senior thesis work on a hybrid solar cell-thermoelectric device, I proceeded with the

SunCoaster-Specs

Guiding philosophy: simplicity, low weight, low cost, unified design.

Motor: Pacific Scientific, 1 hp, 90 V.

Controller: Homebuilt PWM (pulse-width-modulated), 555 Timer, 9 power Darlington transistors.

Operator Control: Hand-operated, spring-return potentiometer throttle.

Battery Pack: Powersonic, 12 A-h lead-acid gel cells, five propulsion (60 VDC), one for Aux (12 VDC).

Photovoltaic Modules: Four Siemens M75 (50 W)solar panels, series-wired, 72 V output, 3 Amp output.

Drivetrain: Motor hub, nine-tooth sprocket, to a 53 tooth chainring on a five-speed Sturmey Archer wheel hub, free-wheeling hub.

Tires: ACS tread tires, 100 psi, 20 inch by 1.75

Brakes: BMX bicycle brakes, all wheels. Two operator levers, one for front and one for rear brakes.

Frame: 1 x 1.5 inch aluminum 6063 rectangular tubing. Seat frame, uprights and bracing: 1 x 1 inch.

Panel mount: Tiltable, 25-degree total arc, rachet pull-down working against two auto pneumatic tailgate lifters.

Instruments: Simpson Wattmeter for solar panels (0–300 Watt), wattmeter for motor (0–1500 Watt), motor voltmeter (0–100 Volt), bicycle speedometer.

Safety features: Roll bar, three-point harness, lap belt, padded tiller, turn signals, hazard flashers and brake lights, horn, electrical disconnect switch, keyed speed controller, two independent brake controls.

Turning radius: 6 feet.

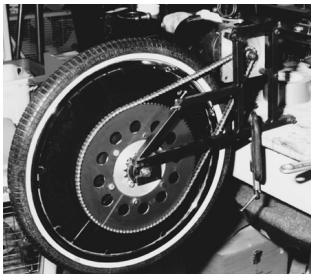
Speed: Top: 19 mph. Cruise: 10 mph, 150 Watts consumption, or 15 Watt-hours/mile. Gasoline equivalent: 2,667 miles/gallon.

Range: batteries only, 11 mph to 70% DOD (depth of discharge), 17 miles.

Range: summer sunshine (calc), 120 miles.

Weight: 220 pounds

Dimensions: Length (7.5 feet), Width (4 feet), Height (4.5 feet), max load: 220 pounds.



solar vehicle and the design and testing of a dependable speed controller. My 17th version worked great and has continued to work without problems for the past two years! SunCoaster runs very smoothly on good surfaces. It is stable, partially because of its low center of gravity. There's no flex in the suspension, so bumpy surfaces are unpleasant to some drivers. We had the vehicle running before SEER '92.

SEER '92 was fun, the vehicle ran well, and we enjoyed having it on display. With our lightweight driver, Toni Van DeKop, we successfully drove the rally course, taking first place in the Innovative "A" Solar-electric category.

In 1993, our physics department hired a new machinist, Steve Attinasi. Along with student Marc Saxowsky and myself, the three of us spent some effort in refining the vehicle and improving the safety features. SunCoaster has been in several alternative energy fairs and auto exhibits, including the Portland Roadster show in March of this year. We plan to attend SEER '94.

Final Thoughts

Benefits from the project includes valuable experience in machine work for a student, the construction of a well engineered solar vehicle that focuses interest and much discussion concerning solar energy, and school interaction with many local businesses.

What would we do different? Use a three-speed hub for more durability, increase the capacity of the solar panels, and add disc or drum brakes.

Access

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Eileen Niedermann graduated and is a Peace Corps worker in Tanzania.

Electric Vehicle Wiring: Part One

Shari Prange

When converting a car to electricity, the wiring requires more meticulous care than any other part of the project. Glaring errors (such as connecting the wrong things together) will produce glaring results (such as a complete failure to operate or spectacular pyrotechnics.) More subtle errors, however, can be just as disastrous, but may lie dormant for some time before striking. It's not that difficult to get it right, if you take the time to pay attention to details.

Wire Sizes

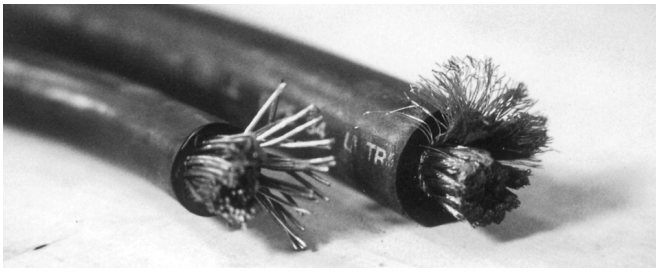
Wire size is determined by the current it will be carrying and the length of the wire. Too much current on too small a gauge of wire will cause inefficient operation, and possibly a fire. A small gauge of wire that is suitable for a short run will not carry the same current for a longer run.

The higher the number of the wire gauge, the smaller the wire, so that 12 gauge is much heavier than 18 gauge. The heaviest wires, actually cables are labeled 0, 2/0, or 4/0. Although wire smaller than 16 gauge may be perfectly acceptable for many applications, it can be difficult to work with because it is so fine. In general, 16 gauge wire is suitable for any automotive application drawing less than 12 amps. For higher current applications, use 10 gauge or larger wire.

Cable

For any components that will see actual drive current of up to 400 amps or more, use 2/0 cable. These components include batteries, the motor, the controller, the main contactor, the circuit breaker, and the shunt.

There are different kinds of 2/0 cable as well. The standard 2/0 cable uses dozens of wires the size of paper clip wire, all gathered into one insulating sheath. This cable is fairly rigid, and can be difficult to work with in tight quarters.



Above: Both regular 2/0 cable (left) and welding cable (right) contain the same amount of copper, but the welding cable is much more flexible. Photo by Shari Prange

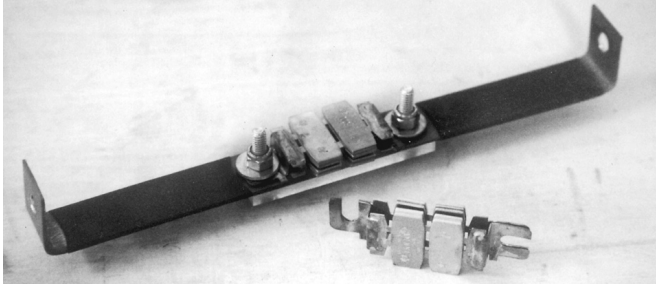
Welding cable is much more user-friendly. It is also 2/0, and contains the same amount of copper. However, it is in the form of thousands of strands the thickness of hairs. This cable is much more flexible, and has thicker insulation to give it more protection.

Copper Straps

For some applications copper straps work well in place of cable. These are places like connections between batteries, which are fairly short and straight. Be sure to use a large enough piece of copper. Strips 1/16 inch thick and one inch wide will give you approximately the same amount of copper as 2/0 cable.

Copper straps are nice because they afford a large contact area at the end, and don't require the extra expense and operation of crimping on a lug. Drill 5/16 inch holes in each end to bolt to the battery posts and deburr them. Then insulate all the contact ends of the straps with heat shrink tube before bending the ends to fit the post.

It is standard practice to have at least one bend in each strap to give it some spring and reduce the stress on the battery posts when they are jostled during driving or collisions.



Above: Copper strap, insulated with heat shrink tubing, is used to mount a fusible link between two battery posts. Photo by Shari Prange

Basic Principles

Each car, of course, will have a different wiring layout, and different brands of components will be connected in different ways. However, there are certain basic

principles that will apply to any conversion. These principles are especially important in a moving car, where wires are exposed to hazards not found in a stationary application like a house.

Identifying Wires
Even a reliable electric car will sometimes require troubleshooting, or the addition or replacement of components. This will be more easily accomplished if all the wires are easy to identify.

Automotive wires are traditionally coded by color. The worst thing you can do (and it has been done!) is to wire the entire car in one color. This effect looks pretty to the automotive naif— and looks hilarious to the automotive mechanic.

If you are using any of the car's original wires and find it necessary to extend them with additional wire, match the original color as closely as possible.

Often, these wires will have a base color, then marking it in the contrasting stripes or bands. You can match this by using a wire that matches the base color, then marking it in the contrasting color at intervals. The marks can be made with automotive touch-up paint or model kit paints from a hobby shop.

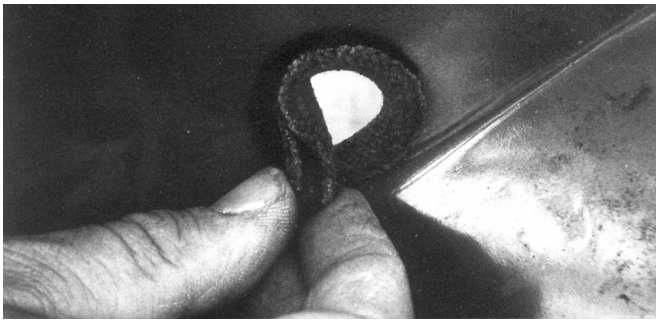
If you are adding new wires, develop your own color code, and make it as consistent as possible with the conventions of the car's original system. For example, if your car is a Volkswagen, brown wires are always ground wires.

Most important, record the color and location of every original wire that you turn to a new purpose, and every wire you add. This is your wiring service manual.

Protecting the Wires
Wires in a car need more protection than wires in a house. When a car moves down the road, everything in it is also jiggling and moving in relation to everything else in the car. Abrasion, snags, and fatigue are risks. If a wire breaks, pulls from its connection, or has damaged insulation, you will have problems ranging from components that don't work to a major vehicle fire.

A wire should never be left to dangle where it might get snagged and pulled. Conversely, it should never be stretched taut so that it strains the connection at the end. Wiring should be like the leash of a well trained dog walking at heel: it doesn't drag on the ground or catch in the bushes, but it doesn't choke the dog, either.

Similarly, a wire should not be pulled across the edge of a component or piece of bodywork, even if it is a smooth edge. Normal road vibration will cause rubbing and abrasion. Eventually, it will wear through the insulation and the wire will short out.



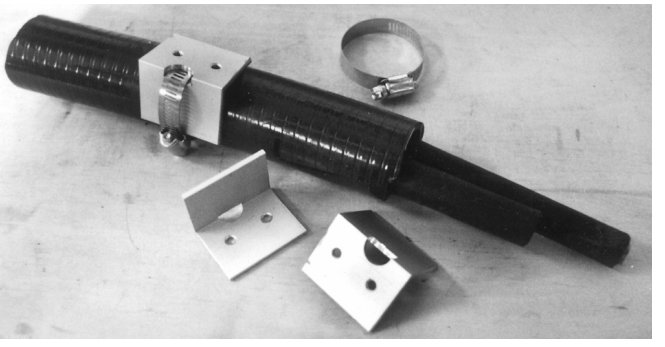
Above: A custom grommet can be easily made from a length of VW fuel line that is slit along one side
Photo by Shari Prange

If wires need to be run through holes cut in sheet metal, the hole should be grommeted. If you can't find an appropriate size of grommet, you can make one. Use something like VW fuel line. This is a narrow rubber hose with a braided cloth covering. Cut a short piece of it and slit it lengthwise. The fill it will body trim cement and work the slit over the edges of the sheet metal. Trim it to fit, and wipe away any extra cement.

The same principles apply to cables as to wires. When running cables underneath the length of the car, they can be protected by a sheath of flexible PVC hose. This is sold in sprinkler and spa supply stores in various diameters.

Looms
Although the shortest distance between two points is a straight line, that is not necessarily the best route for wires. Placing each wire individually from its source to its destination will yield a jumbled and confusing display known as the "explosion in a spaghetti factory."

Gather wires running in a similar direction together into looms, and let each wire peel out of the loom as it



Above: Flexible PVC spa hose can be used to protect cables, and can be easily mounted to the car with simple brackets and clamps.
Photo by Shari Prange

passes its destination. Often, you can follow and attach to the original wiring loom. The wires can be gathered together with periodic strips of electrical tape or nylon tie-wraps.

Even better are loom sheaths such as spiral wrap or Flexgard. These protect the wires from abrasion as well as gathering them together. Spiral wrap is exactly what it sounds like: it wraps the loom in a spiral, allowing wires to be pulled out between loops when they need to exit the loom. Flexgard is a corrugated plastic tube with a slit down one side. The loom is fed into the tube and secured with tie-wraps at intervals, and individual wires are released as needed through the slit.

For very short runs, you can also use heat shrink tube. This is a very effective sheath, but unlike spiral wrap or Flexgard, it cannot be easily opened and closed again, and it allows no easy exits for the wires.

For an instant loom, you can use four-in-one trailer lead. This is a ribbon of four separately insulated and colored 16 gauge wires glued lightly together along their edges. As each wire reaches its destination, it can be peeled away from the ribbon.

Looms make the car easier to work on, reduce the danger of damaged wires, and look professional.

Next time we'll talk about measuring wire and cable, making good connections, adding extra wires, grounding, relays, and fuses.

Access
Shari Prange, Electro-Automotive, PO Box 1113, Felton, CA 95018 • 408-429-1989

Adding Dynamic Braking to a Series-Parallel Controller

Michael Hackleman

Dynamic braking is similar to regenerative braking in an electric vehicle (EV). Both use the motor as a generator during the braking process, and both "brake" the vehicle, converting momentum into electricity. However, whereas regenerative braking uses the *battery* as a load (by charging it), dynamic braking uses a *resistor* as its load, dissipating momentum as heat. If you hate the thought of throwing away the power, ask yourself a question. What do you think you're doing each time you use *any* brake?

In HP #39, I described a simple series-parallel, voltage tap circuit for controlling a small PM (permanent magnet) motor that incorporated a regenerative braking circuit, too. This circuit is easily expanded to provide dynamic braking. This article shows you what dynamic braking is, how it works, and how it can be integrated with the previous circuit. As well, I will explain how to position the operator controls, what safety features are provided, and how to fabricate the resistor coils.

Note: This circuit assumes the use of a PM (permanent magnet) motor. Series, shunt wound, and AC motors will not produce a braking effect when merely connected to a resistive load. See "Regenerative Braking a DC Series Motor, Otmar Ebenhoech, HP #38, for the control requirements of series motors to produce a braking effect.

When is Dynamic Braking Used?

It is important to understand that regenerative braking and dynamic braking are complementary braking techniques. That is, they should act *sequentally*. Regen works for high-quality electricity; dynamic braking handles low-quality power.

Realize that as any vehicle slows down, its drive motor also slows. Rpm drops, voltage drops, if regen is engaged, then current drops. Very quickly the motor voltage drops below the battery voltage and electric current ceases.

Long before this happens, the braking effect *fades*. This occurs as the two values of rpm (motor and wheel) close with one another. You can regain the electric braking effect in three ways:

1. Shift down. *if* the vehicle has a transmission, this is a good time to shift down to a lower gear. This will increase the difference in motor rpm (and its voltage) and pack voltage. Current flow will increase, as will the braking effect.

2. Go from series to parallel wiring of the battery pack. *if* the battery pack can be "shifted" from series to parallel, i.e., from 24 V to 12 V, this will increase the difference between voltages and, in turn, increase the braking effect.

3. Shift into dynamic braking. *If* the vehicle has this circuit, use it now.

All of these tactics only *postpone* the moment when the vehicle has slowed enough and you must use the vehicle's drum or disc brakes. Whether mechanical or hydraulic, these should bring the vehicle to a stop. In the smaller vehicles, a well-designed dynamic braking circuit will halt the vehicle.

The Value of Dynamic Braking

Dynamic braking (DB) takes over when regenerative braking fades. How does it work? When engaged, the DB circuit shifts the motor's output to a resistor. Unlike batteries, resistors do not have a voltage potential. For this reason, they will provide a load until the voltage is altogether gone. Resistors have two values of importance: their resistance and their heat-dissipating capacity. The first is measured in ohms and the second in watts. (More on this soon).

A Basic DB Circuit

Fig 1 illustrates a basic DB circuit. Switch S4 is a push button (momentary contact) switch, relay K4 is a 12 V automotive contactor, and R1 is a nichrome resistor. K2 is similar to K4, which is part of the motor controller circuit that routes battery power to the motor. (Note: Circuit components are assigned numbers that will reflect their combination with the series-parallel motor circuit described in HP #39.)

How does the DB circuit work? With K2 de-energized, the motor is disconnected from the batteries and is essentially freewheeling. Here, the vehicle is slowed only by the friction losses of drive train, tire rolling

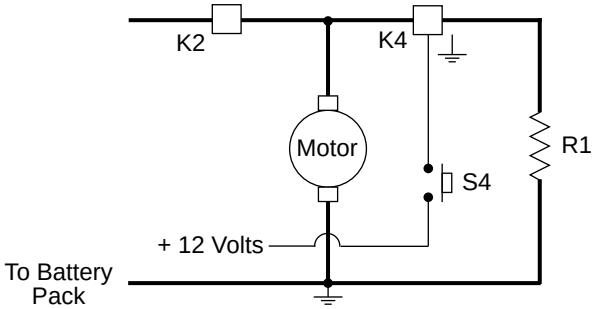


Figure 1

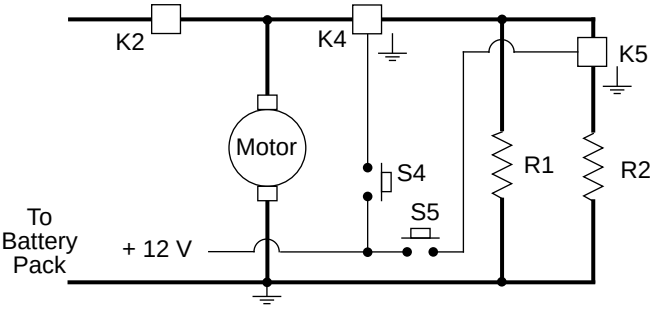


Figure 2

resistance, and aerodynamics. Want more braking? Push switch S4. This energizes relay K4, which connects resistor R1 to the motor.

The permanent magnets of a PM motor supply a constant magnetic field. If the motor's shaft is spinning, lines of force (flux) are cutting electrical wires. When a path is supplied for electrons to flow, they will! The DB circuit does this, and resistor R1 is the load. Current will flow, limited only by the resistance value of R1. Since it takes power to make power, the momentum of the vehicle (connected through the motor, drive train and wheels to the road) is converted into electric current that is dissipated. The vehicle slows down and resistor R1 heats up! Why bother? A good DB circuit will significantly reduce brake wear and greatly increase the braking strength of the vehicle that uses it. Thus, $25 in parts can save a brake job costing 10-15 times as much.

This effect will continue until the vehicle has come to a complete stop. However, like the regenerative braking circuit, the braking effect produced by this DB circuit will fade as the motor slows down. With less voltage, there is less current (ah, yes, the constancy of ohm's law, E=IR!).

A Two-Position DB Circuit

Want more braking effect? Add another relay, resistor, and switch. Fig. 2 illustrates a two-position DB circuit. When switch S5 is pushed, relay K5 energizes, adding the value of resistor R2 to the circuit. If it had the same resistance value as R1, its addition to the circuit in *parallel* with R1 cuts the overall resistance in *half*, increasing the current flow from the motor *and* the braking effect.

Note that I have wired K4 and K5 in *series* with each other. Wired this way, current cannot flow in K5 until it is flowing through K4. Why is this important? There are three virtues to this layout: safety, sequence, and reliability.

1. Safety. Energizing K4 initiates *soft* dynamic braking. Energizing K5 energizes *hard* dynamic braking. Believe me, you don't want *hard* braking before *soft* braking! Wired this way, energizing K5 before K4 produces zero results. This tends to force the sequence from *soft* to *hard.*

2. Sequence. Braking should be a smooth progression. If K4 and K5 are wired in parallel, there will be a gap as you shift (electrically) from one to the other. It is annoying and jerky, at least. It could result in a lost of traction, too. The same goes for backing off on the braking. Sometimes you will want to move smoothly from *hard* braking into *soft* braking. Make sense?

3. Reliability. Relays, like switches, typically work the hardest when they *break* a circuit. Current has been flowing, suddenly a crack opens in the circuit, the voltage will tend to push the electrons across this increasing gap, and the result is "arcing". Arcing is good in welding. It causes metal to be transferred from the rod to the work. Arcing is bad for a relay's contacts. It causes the metal of one contact to be transferred to the other contact, pitting one contact and building a bead on the other. It heats and burns, too. Burned contacts become resistive, heat up even more, and eventually fail, often welding themselves together. So much for reliability.

With relays K4 and K5 wired in series, the vehicle operator's decision to *decrease* the braking effort allows an alternate path for motor current as K5 is de-energized. It continues through R1. Thus, K5's contacts do not break the *full* motor current. If the operator wants to *end* dynamic braking, i.e., releases the hand lever, both K4 and K5 will de-energize *simultaneously*. If you think about it, the combined opening of contacts in both K4 and K5 equates to "further and faster", further suppressing motor current arcing. The same relay contacts wired in parallel do not benefit from this idiosyncrasy.

The Combined Regenerative and Dynamic Braking Circuit

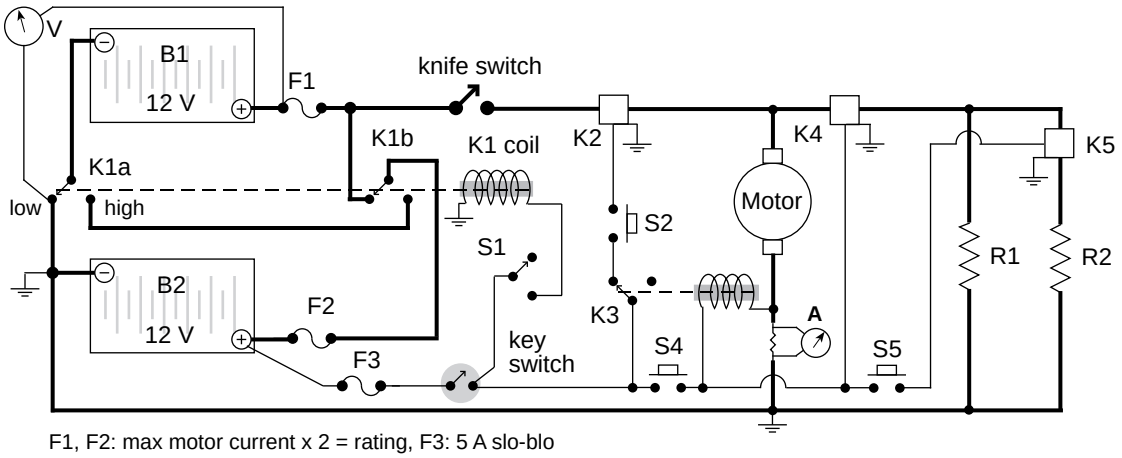
It is time to merge the dynamic braking circuit with the series-motor controller and regenerative braking circuit. First, let's take a test drive.

You are out on the highway, whizzing along in your Electron Cruiser, just starting into a winding downhill section. You take your finger off the GO button (S2). You are coasting, but you want to go slower. You toggle switch S1 into LOW (shifting the battery pack from series to parallel wiring). When you push switch S2 again, you feel the regenerative braking. Isn't life great! You are slowing down *and* recharging your batteries simultaneously.

You come around a corner and spot a deer and fawn standing at the edge of the road. They can't hear you (you're silently electric, remember!), so you don't know what they will do. You decide to slow down even more. You start to apply the brake lever when you remember: Hey, I've got dynamic braking now! You let go of the GO button and push down on the other push button (S4). You feel the tug as the dynamic braking circuit is engaged. Want to slow more? Grasp the brake lever a bit (still pushing down on S4) . Automatically, switch S5 energizes relay K5, increasing the braking effect. Whoops, there goes the fawn, right into your path. You hit the brakes harder, and stop in time.

Fig 3 shows the complete circuit diagram that makes everything happen. (Compare this with the circuit presented in HP #39). Most of the components — for series-parallel, regen, and dynamic braking functions — should be recognizable. However, there's a *lot* going on behind the scenes in this circuit. More specifically:

Figure 3



F1, F2: max motor current x 2 = rating, F3: 5 A slo-blo
Wiring: Motor circuit: #10 stranded or larger. Control circuit, Metering: #18 stranded or larger
Digital meters: Radio Shack, Micronta model 22-171A. Shunt: 50 Amp 50 mV

1. Relay K3 is identical (in ratings) to relay K1. Since only one pole is used in K3 (half that of K1), a suitable SPST relay can be substituted.

2. Switch S4 is identical to switch S2. Since S4 is for STOP and S2 is for GO, it would be helpful if switch S4 had a red button. Ideally, S2 would have a green button: however, blue, white, or black will do nicely.

3. Relay K4 and K5 are identical in type (auto starter contactor) to relay K2. Their high coil current requirement is of limited concern because they are used infrequently and briefly.

4. The key switch in this diagram is labeled S3; it had no such assignment in the circuit diagram in HP 39.

5. Switch S5 is a microswitch that is attached somewhere in the vehicle's stock (drum or disc) brake system. Whether manual or hydraulic brakes exist, this switch should function in the same way as the brake light switch, only sooner. There is always a certain amount of lever travel before stock brakes actually engage. You want S5 to activate first. If you need more braking, you can *add* the effect of the stock brakes.

Why isn't S4 also wired into the brake lever, and sequenced to close before S5? Dynamic braking should be activated *only* when the driver wants it. Depressing S4 requires a decision, a special effort of the brain. A panic stop from high speed by the driver, on the other hand, is a reflex. If dynamic braking was activated at the brake lever, what would happen to the vehicle? Going from high speed to hard dynamic braking could lock up the wheel(s). It could snap a chain, strip a gearbelt, or rip the motor off its mount.

STOP or GO?

In real life, you can Stop or Go — but you can't do both. I've built the same ideology into this circuit. Relay K3 is wired so that its contacts, de-energized, allow switch S1(the GO button) to energize K2 for propulsion. When switch S4 (essentially the STOP button) is pushed, it does more than energize K4 for dynamic braking. It also energizes relay K3, *disabling* relay K2. This way, even if S2 is

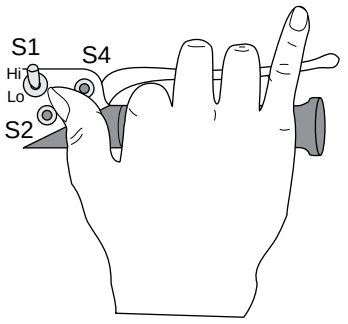
pushed, relay K2 *cannot* energize. This is a *failsafe* feature. Relay K2 and K4 must never energize at the same time. If they did, the battery pack would be shorted to ground through resistors R1 and R2. A wasteful use of power, at least. And some cherry red resistors! Blown battery fuses, more likely.

Ergonometry and Safety

Ergonometry is the science of fitting humans to objects and machines. On the surface, the more natural, or easy, or intuitive you can use something, the more you'll like it and the better you'll interact. Most consumers have no idea how much design effort is often devoted to easing their interaction with a device. Beneath the surface, the goal of ergonometry is more primitive. It wants you to survive the experience. It's trying to keep you alive.

A critical aspect of the circuit represented by Fig 3 is the positioning of switches S1, S2, S4, and S5. As indicated, S5 *must* be connected into the brake system. The other three switches, one a toggle and the other two push buttons, *must* be mounted in close proximity with one another and *must* be activated by the same finger or thumb.

Caution: If you violate this ergonometric arrangement, you have compromised the design of *this* circuit. No, you cannot mount one switch near one hand and the other two by the other hand. No, you cannot directly adapt this to a brake pedal. No, you cannot combine S4 and S5 into a multi-position switch. This circuit design is the *result* of much thought and experience. Dozens of alternate layouts have been discarded. Honor this or don't use the circuit.



Selecting the DB Resistor Values

Three criteria are involved in the selection of R1's values (ohms and wattage): extension, duty cycle, and operational weight.

1. Extension. Engaging dynamic braking should *feel* like a natural extension of regenerative braking. So, it should feel like the next detent in the braking effort. Some experimentation and adjustment of this value will be needed. Allow for it.

2. Duty cycle. The resistor may be called upon to dissipate a *lot* of heat. This suggests a high wattage rating. However, pumping braking power through this resistor involves a relatively short duty cycle. Hard braking is less likely to heat it up as a long downhill section of road.

3. Operational weight. For a 350-lb operating weight (vehicle and driver), the value of R1 is likely to be less than one (1) ohm. For example, 15 volts of motor output will produce 15 amps of current in a 1 ohm load. A 225-watt braking effort (roughly 1/3rd of a horsepower) is *not* much. Half the operational weight would find this substantial. Double the operational weight would hardly notice it.

Building Resistors R1 & R2

Due to the high wattage requirement, a resistive coil is the obvious choice for the dynamic braking resistors, R1 and R2. You may need to wind your own. As previously mentioned, when two resistors of the same value are paralleled, the overall resistance is cut in half. When the same two resistors are wired in series, the total resistance is doubled. So, measure out a length of the wire material you choose and wind it to a size and shape that will fit its location. Now, try out the circuit with a short road test. Too much braking effect? Wire a duplicate coil in *series* and re-test. Not enough braking effect with one coil? Wire a duplicate coil in *parallel* with the first one. Continue either process until the desired braking effect is achieved.

Wire coil material is important. Do not use copper and aluminum wire. The best choice here is nichrome, a special resistive wire (or ribbon) found in floor heaters and toasters. See the wire that glows cherry red? That's the stuff.

Nichrome comes in a variety of values (ohms per foot) but your application is unique, so this value is unknown — and I can't tell you offhand. This is why scrounging the nichrome ribbon from old (even broken) toasters or floor heaters is a good bet.

Follow me as I build a wire coil for dynamic braking. First, find and begin dismantling a toaster or floor heater. You want that portion of the nichrome wire (or ribbon) that normally gets red hot in use. In a two-hole toaster (takes only two pieces of bread), there are four grids, one for each side of both pieces of bread. In the floor heater, the ribbon is usually bent around porcelain standoffs, and runs back and forth across the length. In either, carefully separate these areas from the rest of the components and housing. (Do I need to remind you to unplug these appliances first?)

In the toaster, look carefully at the way the grids are wired to each other. Are they just one long strand of nichrome? Or are two or more of them arranged in parallel?

Now what? Toasters and floor heaters are usually rated about 1,200 watts at 120 volts. Amps equals watts divided by volts. Thus, the current is 10 amps. If the toaster's four grids are connected in series, each is rated at 300-watts at 30 volts. In the floor heater, half of the ribbon represents 600 watts at 60 volts. What's needed in the dynamic braking coil? If your vehicle's motor voltage has dropped to 15 volts, one toaster grid (or 1/4th the heater's ribbon length) represents, at 10 amps current, about 150 watts of heat. This is probably a good braking effort. Try doubling this amount in series (or half the windings in the toaster or heater) for your first test. A braking effort that's too soft the first time you test it is better than one that's too hard! Adjust accordingly. Duplicate the process for R2.

Once you've succeeded in finding the correct length, shape the nichrome into a more manageable size. If it's nichrome wire, form it around a small, hard object, the thickness of a AA battery or larger. If you're using nichrome ribbon, shape it into a zigzag shape with needle nose pliers. Bend the ends of the ribbon at a 45 degree angle to itself to make 90 degree turns. Pinch the bent ribbons ends between large diameter washers to secure it to the contactor posts of K4 and K5. Position the resistor in a heat-dissipating airflow, away from anything that can melt or burn.

Avoid DeMag Currents

PM motors have demagnetization ratings. Expressed in amps, this is the amount of current that will cause the magnets to lose their magnetism — when working as a motor OR a generator — PERMANENTLY! The demag rating is usually about 4 times the continuous rated current at design RPM. Your dynamic braking circuit should never allow this kind of current to flow for more than a second!

Despite the sinister aspect of demag currents, PM motors can, in small vehicles at low speeds, be safely shorted out! Really, it's a common technique! In this case and for this circuit, then, resistor R2 could be eliminated, with relay K5 simply bypassing resistor R1. If experimenting suggests that this will work for your vehicle, substitute a slowblo fuse for R2 rated at the demag current value.

Access

Michael Hackleman, PO Box 63, Ben Lomond, CA 95005. Or c/o Home Power Magazine.

Relay (K1). 2PDT, P&B, 12V coil (.25A), 25 amp (contact) rating, 240VAC. RL8951 is $9.95 from C & H Sales, 2176 E. Colorado Blvd, Pasadena, CA 91117.

Relay (K2)12V contactor is standard automotive (old-style) starter motor solenoid. Check your auto store

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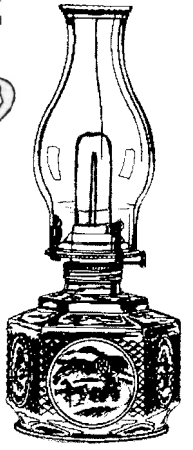

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Don Loweburg & Bob-O Schultze

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The Case for Intertie

In most regions, the best model for full utilization of renewables has many small rooftop PV arrays, backyard wind towers, and small hydroplants producing and consuming electricity in a localized area. There are great advantages both to the consumer and to the utilities with this scheme. For the utilities, transmission losses and line upgrades are minimal. Power wheeling and bringing generators on-line for peak load periods can be greatly reduced. The environmental considerations and huge capital expense associated with bringing new generating facilities on-line are no longer the utilities' problems. For the consumer, owning your own RE system can lock-in your long-term electrical expenses and provide a uninterruptible power supply when the utility grid goes down. An RE system will increase the value of your home or property. Producing your own power using RE is one of the best things you can do for our environment. Grid intertie eliminates most of the need for batteries, the least environmentally benign part of an RE system.

Selling your Power

Utilities, by federal law (PURPA 1979), have to buy your excess electricity. However, they use many different methods of payment for user-generated power. The method used depends on how much (or little) they want your power, how environmentally conscious or politically correct the utility wishes to be, and, in the case of an investor-owned utility, how they perceive IPP-owned RE systems affecting profits. Many utilities are extremely conservative monopolies and bureaucratic nightmares. Be patient, it may take awhile to work through the chain of command. Do your homework. Be ready to explain that your PV or wind system produces power on-peak when the utility needs it the most, unlike the larger IPP hydro models that they are familiar with.

Methods of Payment • Straight avoided cost

This is the least desirable and least IPP friendly method. It is a two meter system where you buy all your electricity at the going rate and sell all the output of your renewable sources at the rate that the utility claims it costs them to produce power, usually around 2¢ per kiloWatt-hour. It is a port over from mid-size IPP hydro systems and is totally unsuitable as a basis for payment for power generated by IPP solar or wind systems. Any utility using this method is telling you two things: 1) we don't need or want your power and 2) the environment be damned, we're here to make money.

• Net Billing

With this method, power generated is paid for at the same rate as power consumed. Usually metered by a single bi-directional counter which runs backwards when generation exceeds demand. This is the best scenario from the IPP standpoint. It encourages independently owned RE generation and is the system used by utilities with an environmental consciousness and/or those who are looking into the future.

• Net Billing to Parity

Under this scheme, RE generation is paid for at the same rate as power consumed until there is a surplus. Any excess power fed back to the utility is paid for at the avoided cost rate. A single bi-directional meter can be used and read monthly just like any other meter. To be completely fair, a once a year accounting and "settling up" would average out the sunny or windy months with those when the user is consuming more power than they are generating. While this scenario stops short of encouraging IPP generators, at least it doesn't discourage them from producing their own power. The utility gets to keep a customer *and* make a profit on excess generation. In the case of PV and many wind installations, the excess *only* comes during peak load periods when their power generation costs

are highest. Where the utility must buy power off the grid on-peak, excess PV and wind generation saves even more than average avoided cost.

California Update – SCE's Offgrid Program

As reported in HP #41, a number of requirements were added by the California Public Utilities Commission (CPUC) to Southern California Edison's offgrid PV program. In addition to added compliance supervision by the CPUC, the requirement to conduct a market survey is probably the most important single item. It will provide a baseline by which the promises and claims made by Edison will be evaluated. Edison has contracted with Neos Corporation of Colorado (Neos describes itself as doing a lot of work for various utilities) to do this study. The study will attempt to quantify current and potential PV users as well as offgrid service providers in the Edison service area. It's important that this information be accurate and complete. Neos has been provided with a list of California IPP members. We are happy to note that *Home Power* will be doing a survey as well. Look for the survey form in this issue between pages 16 and 17. Home Power alone is bearing the costs of this survey and the results will be published when complete. Please do your part by taking a moment to fill in the form and send it in. While the survey is national, your response is especially important if you live in the Southern California Edison service area. Can we trust the giant investor-owned utility to present their data in an accurate and unbiased manner? As a check on SCE's survey, *Home Power's* results in Edison's area will be made available to the CPUC.

Details of the SCE Plan

In early June, I (Don Loweburg) attended a standards workshop hosted by Edison. At this time, they presented details of the systems they want to provide for offgrid customers. Because these systems must meet National Electric Code standards, "listed" components will be used when available. Specifically these include PV modules, inverters, panel boards, and safety disconnects. Installers will be required to be licensed California contractors, either general electrical (C-10) or solar (C-46) with PV experience. Given the market being addressed here, these are reasonable requirements and IPP can support them. We wonder about some other aspects of the program, however.

First, system sizes will be with arrays of 1 kW or larger peak power output. Now, from our combined experience of over twenty years in the field and thousands of PV systems, these are jumbo systems. The most commonly installed PV systems are 12 modules or less having a peak output of 600–900 Watts.

Second, *every* system we do is custom. Is there a cost-benefit for tracking? Does the site or customer's electrical needs lend itself to some hybrid of PV, wind, or hydro systems? Is the best site for the PVs not a good place for the batteries and controls? In contrast, *none* of these concerns will be addressed by the SCE "auditor" who specifies the system. SCE literally perceives these systems as "power in a box" type installations. One SCE engineer said they should be "easily deployable and removable in a day".

This utility is out of touch with the needs and lifestyles of the offgrid community. It should be no surprise that nothing in Edison's program so far speaks to customer education about load reduction and conservation. What's the net result of a program like this? *To Drive up the cost of a PV system!* Short term profit for a few in the PV industry, a healthy bottom-line for Edison's investors, and the public will be led to the conclusion that PV costs too much. This, in turn, will lead to *less* deployment of photovoltaics and we all lose in the long term.

Co-op vs. Investor Owned Utilities

We've been asked, "what's your beef with utilities?" Before that question can be answered, we need to make a distinction between kinds of utilities. Co-ops and municipal utilities are in a special class. They have elected boards and are created to serve as "not for profit" service providers for their communities. While they may need some education as to the untapped potential of IPP owned and operated renewable energy systems, there is no pressure to protect and increase profits for their investors. These elected boards must, sooner or later, reflect the wishes of their constituents in any move toward a renewable energy policy. On the other hand, IOU's (Investor Owned Utilities) are "for profit" monopolies serving the interests of their investors. They make money from ratepayers. IPP members, those of us in business, make money from customers too. The issue is, we don't think it's right to have to compete with monopolies in a market that we have developed. Keep in mind that, until now, Edison refused to serve offgrid folks except by unbelievably expensive line extensions or not at all. Many offgrid homeowners were told that PV simply doesn't work. Nor can we trust them to develop these new technologies past the point where it increases profits. Environmental concerns or "externals", as they are known within the power industry, are simply not a concern except as they apply to offsetting the pollution clean-up costs of traditional electrical generators. At the same time, don't forget that IPP-owned PV, wind, and other renewables offer the end user, whether offgrid or grid-connected, the possibility to bypass the utility entirely or eliminate the monthly power bill. This

potential loss of income or "turf" is the topic of a great deal of discussion within the utility communities!

For IPP Members

This summer we will be incorporating. We need nominations for officers and donations for legal expenses. Start thinking about it now. We plan to spend some time on this at SEER '94 in Ukiah.

We are being asked for installer referrals more and more frequently. This is a major service we plan to offer to the public. Lead installers will need to be qualified licensed contractors who may head up regional teams to offer quality installations of all types of renewable energy systems. If you are "in the biz", licensed AND qualified, this is a good opportunity for referrals. If you are experienced and qualified but unlicensed, we'll try to put you in touch with a licensee in your area. An infrastructure is in place in California but we want to be a national clearinghouse for renewable expertise and experience.

Access

National: Bob-O Schultze, Electron Connection, POB 203, Hornbrook, CA 96044 • Fax/Phone 916-475-3401

California: Don Loweburg, Offline Independent Energy Systems, POB 231, North Fork, CA 93643 • 209-788-7080

Solar Heating Basics

Part Two — Storage of Solar Energy

Tom Snyder

The amount of energy we receive from the sun in one day far exceeds what we can use. One simple solution to use this excess energy is store it. With photovoltaic modules or a wind generator, we store this surplus electricity in a battery system. With a solar panel, we store sun-heated water or air in a storage tank of water or rocks.

In *Home Power* #40 I described the basic solar heating panels — air and liquid — and how a DIY might build their own. But, solar panels without a storage system is like an electric car without batteries! In this article I will simplify some storage methods, present common pitfalls to avoid, and describe one of the cheapest and best methods I have ever used for storing heat in a tank of water.

Typical materials commonly used for storage of solar heat are those with a great amount of mass, such as cement, rocks, or water. Cement is usually only used in passive solar designs, while rock and water is used in active systems.

Rocks

If there is any doubt about rocks or cement storing solar heat, just feel a 300 pound boulder or a cement slab on a sunny afternoon. The ability to store heat is referred to as a substances' specific heat, and both water and rocks have a high specific heat because they have a large mass. During the early 1970's solar companies tried to develop a storage system using rock. A few of the biggest problems:

1. The amount of material was enormous! In some cases half the basement stored solar heat.

2. Moving heated air from the panel through the rock required the rock to be small, like pebbles, for more surface contact with air.

3. When house air was blown through the rocks to distribute the heat, this cooled the rocks and created the biggest problem — condensation and mold.

In this area of Iowa, few such storage systems were installed. One reason is that water stores more energy per pound.than any other substance (more specific heat) and doesn't take as much room in the basement, and second, no mold.

Water

Using water for storage of heat has many benefits. One of the best is that we can use this heat year round — you can take hot showers, as well as heating your home! Year round use is one of the economic reasons used to justify solar panels.

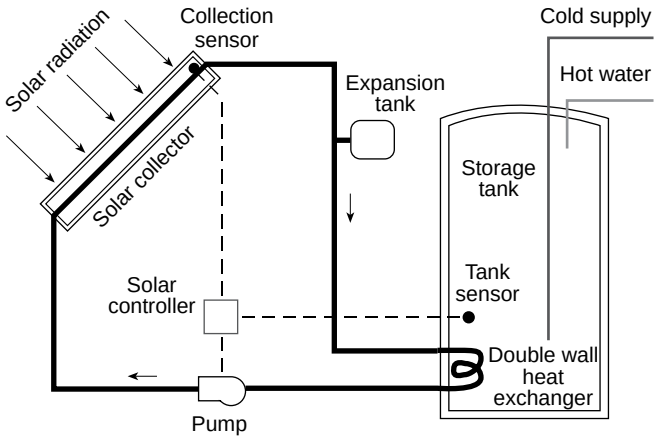

Figure A: Glycol heating with heat exchanger

Storage systems — pressurized or unpressurized

Pressurized

Domestic hot water (DWH) systems usually have a 40 to 52 gallon tank that is heated by natural gas or electricity. This is connected directly to the incoming.water supply as shown in figure A. This tank can be heated by a solar panel with a heat exchanger, either on the outside or inside the tank. The tank is still under pressure just like the original DHW. Figure B

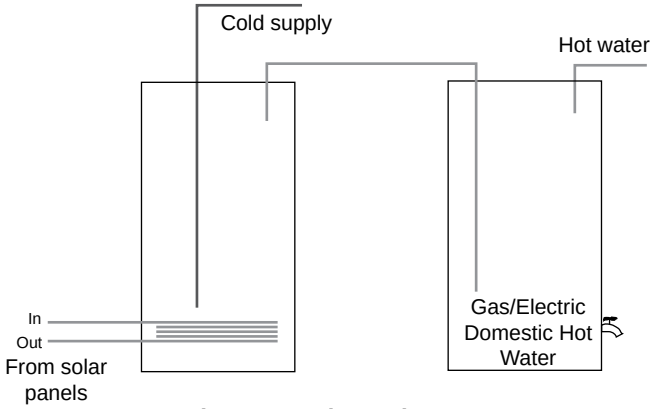

Figure B: Solar preheater

shows how more than one tank can be installed if space is available. For space heating as well as DHW, many tanks can be connected, but it does require a lot of time and planning. I have installed two heating systems this way, and would recommend using the unpressurized method.

Unpressurized

Figure C shows a tank of water (usually 250 gallons or larger) with a copper coil suspended in the top third for preheating the DHW. For one method on how to use the solar panels to heat this tank, consult HP#34. You can also use wood to heat the tank of water via a fireplace or woodstove! (HP#24 and #35). Figure C shows a typical system using solar and wood for both DHW and heat.

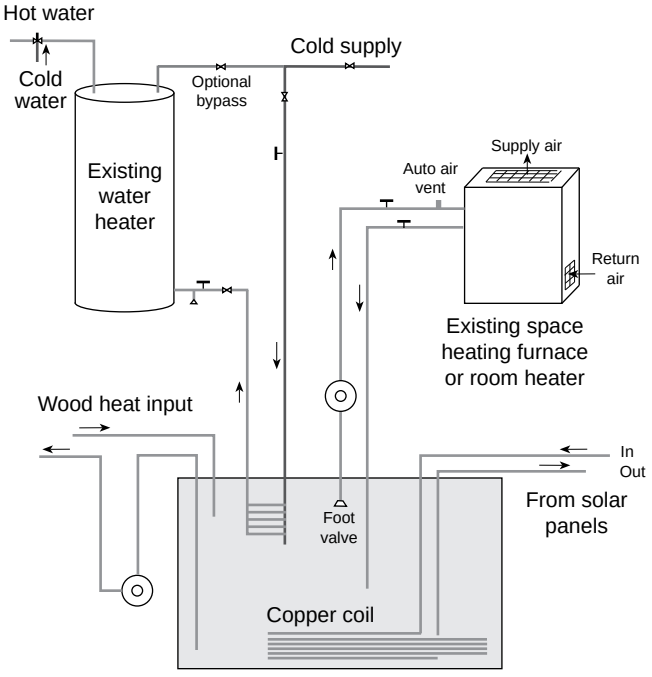

Figure C: Solar and wood for water and space heat

I believe that there is always a better and cheaper way of doing things. In some cases storage of solar heat was the second highest cost on a solar job. In one installation I saw, half the cost was in the storage tank alone. If the tank was labeled for solar storage, it could be $10 a gallon! These tanks were usually plastic of some type and were sometimes made in parts that could be assembled in the basement. Potential leaks did become a major problem.

A second choice for unpressurized storage systems that I liked was a wood box (yes, w-o-o-d) with a synthetic rubber lining made from EPDM. The idea is to keep the height at four feet (standard lumber dimensions) which also keeps the height of the water within reason. The wooden box is six foot long by 4 foot wide and constructed with 2x4 timber on 16 inch centers. The sides and bottom are insulated with fiberglass, and finished with 1/2 inch plywood with 3/8 inch bolts. The whole box is banded with 1/2 inch metal used by lumber yards to band together shipments of lumber on semis.

The EPDM liner is the same material used for seamless flat roofs on school buildings in the midwest. It is thick, durable, and has no temperature limit. The tank temperature can reach 210 degrees, you know! This was a real neat method until the cost of EPDM went out of sight. The cost of EPDM went from $1 a square foot to over $5 a square foot (approximately $200 to $1000). One solar job I just inspected a week ago had 1500 gallons of water in a wooden tank with a heavy swimming pool liner. This liner has one warning: limit 180°F!

My final, cheapest, most durable, and futuristic method is used stainless steel bulk milk tanks. Most of my systems became affordable and totally trouble free using these tanks. Farmers have many reasons for replacing 200–300 gallon tanks — they need a larger size, or the external cooling unit leaks freon — but never because the insulated tank leaks. These tanks are insulated, have lids that allow working in the tank, and have a hole in the top for installing all the plumbing from the solar panels, DHW, and heating system. These tanks are available from approximately $1 to $2 a gallon, used, from milk farmers in Iowa. They are so indestructible and neat looking, I suspect they will be recycled a third time as a hot tub.

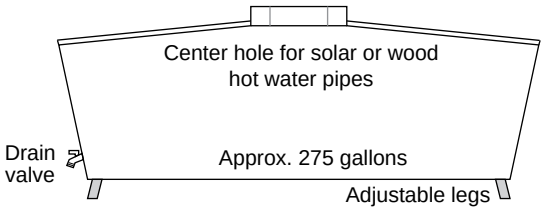

Figure D: Typical stainless steel bulk milk tank

As a parting thought: One customer looked at the bulk milk tank and got a concerned look on his face. Heat rises, right? Well, all the insulation is on the sides and bottom of this tank, right? How do we keep the heat in on the top? I suggested he turn the tank over!

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Tom Snyder, c/o Iowa Renewable Energy Association, Dyersville, IA 52040 • 319-875-8772

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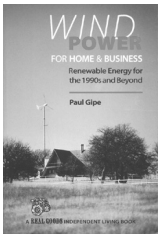

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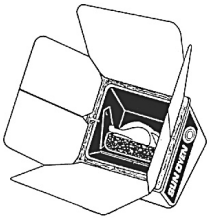

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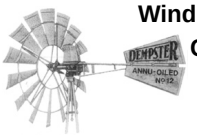

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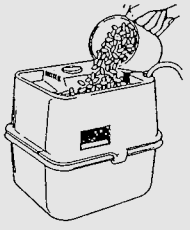

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724SB	700	24	12
DR1512	1500	12	70
DR1524	1500	24	35
U2512	2500	12	
U2512SB	2500	12	120
U2624	2600	24	
U2624SB	2600	24	60
U2232	2200	32	
U2232SB	2200	32	45
U2536	2500	36	
U2536SB	2500	36	40
U2548	2500	48	
U2548SB	2500	48	30
M1512	1500	12	70
U2512RV/M	2500	12	120
U2624RV/M	2600	24	60
U2232RV/M	2200	32	45
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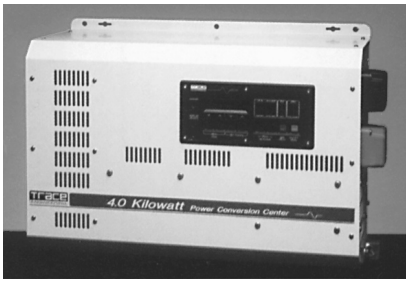

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Solar Slowpump™

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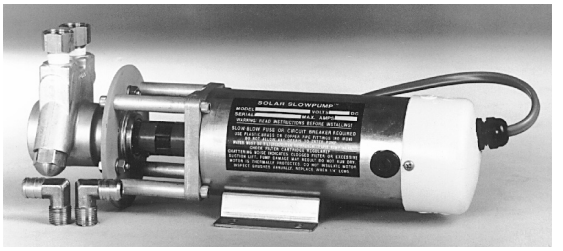


Bob-O Schultze KG6MM

Windy Dankoff's solar pumps have been around for years.Since 1983, the Slowpump™ has been providing PV array-direct water pumping in countries all over the world. Not only have these pumps stood the test of time, but small changes have made them even better. Maybe we should call this Things that Keep Working!

Packaging and Documentation

The pump arrived via UPS in a white (bleached) cardboard box well padded with old newspapers. The installation and troubleshooting manual is designed to apply to all models of the Slowpump™ and the Flowlight® Booster Pump as well. The manual is well laid out with lots of subheadings and large type to make it easy to read and quick to find things. Several drawings illustrate typical pump installations and the section on plumbing and mounting the pump is very good. The electrical section covers the basics, but diagrams or electrical wiring schematics are sorely lacking.

My favorite part of any owner's manual is the "when things go wrong" section. Windy's troubleshooting section is excellent. From water supply to filtration to electrical problems, if it can go south (or north, if you're down under) and there's any chance at all of the user fixing the problem, it's in there. Well done.

The Product

Windy's Slowpump™ uses a high efficiency DC motor (ac available) coupled to a precision vane-type pump. The pump is NSF® approved for drinking water. The close tolerance of the vane pump and the wide variance of acceptable input voltage is what makes the Slowpump™ work so well in a PV direct application. Even during low light levels when the motor is turning slowly, a small amount of water can be pumped. In bright sun with a properly sized array, volumes of over 240 gallons per hour (GPH) or heads of over 400 feet can be achieved. There are eight pump sizes, two motor sizes, and three voltages available. The trick is proper pump/PV array sizing to your site and situation. Nobody does this better than Windy, but many dealers are very competent to help you size a pumping system correctly and avoid some of the pitfalls associated with fusing, wire and pipe sizing.

The Slowpump™ has several on board safety features. A thermal overload switch is installed in the pump motor and protects the motor from overheating. A small intake screen is installed in the intake port of the brass pump head. It's purpose is to catch any material that may flake off your intake pipe or be introduced during installation or servicing. This screen is not designed to be the primary filter for the pump intake. Given the extremely close tolerances of the vane pump, unless your water supply is always crystal clear, external filtration is required.

Windy offers several options for the Slowpump™ including several filter packages, an intake screen/foot valve, and a dry run switch which will shut the power to the motor off in case of pump overheating due to lack of intake water.

The Test

We tested the model #2507 24 VDC Slowpump™. Our test site had water in a small creek being lifted 42 feet through 1 1/2 inch PVC pipe to several large poly holding tanks. Power to the pump was supplied by two Kyocera K-51 PVs wired for 24 VDC on a Zomeworks® two panel Trackrack™. A Sun Selector® LCB-3M-T located at the pump optimized the current/voltage of the PVs to the Slowpump™. We used a gate valve and Weiss 0-30 and 0-100 PSI gauges on the pump's output to simulate head at various pumping pressures. Since our PV array wattage was limited, we also used a set of 65 Amp-Hour gel-cell batteries to test the flow rate and wattage draw at higher simulated pressures. We discovered that the manufacturer's GPM / Watts figures were taken at the higher PV array-direct voltages (30 VDC) and the pump GPM output is reduced by 10–15% at typical battery voltages. Although nothing is claimed either in the manual or the promotional literature about this, the manufacturer

states that this is normal and expected with battery operation.

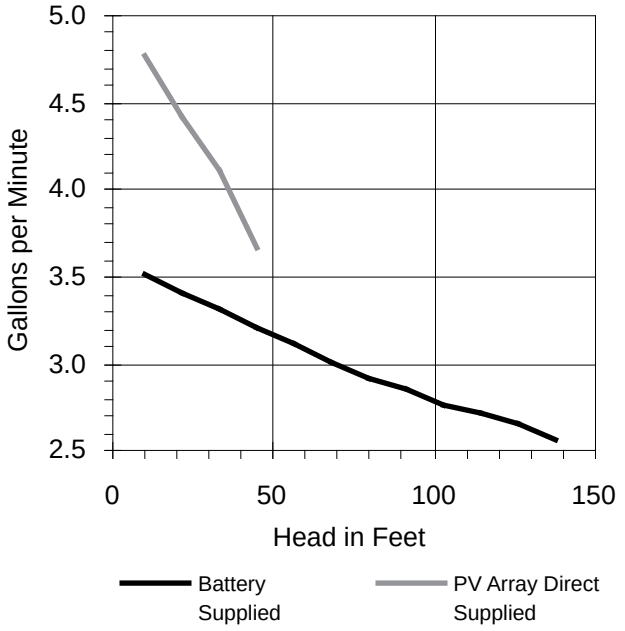
Flowlight Slowpump Test — Model 2507

Battery Supplied

Pressure in PSI	*Head in feet*	*Gallons per min.*	*DC Amps*	*DC Volts*	*DC Watts*
5	11.6	3.50	1.33	24.7	32.9
10	23.1	3.40	1.76	24.6	43.3
15	34.7	3.30	2.14	24.6	52.6
20	46.2	3.20	2.53	24.5	62.0
25	57.8	3.10	2.53	24.4	61.7
30	69.3	3.00	3.33	24.4	81.3
35	80.9	2.90	3.93	24.3	95.5
40	92.4	2.85	4.44	24.2	107.4
45	104.0	2.75	4.94	24.2	119.5
50	115.5	2.70	5.51	24.1	132.8
55	127.1	2.65	5.97	24.1	143.9
60	138.6	2.55	6.41	24.0	153.8

PV Array Direct Supplied

Pressure in PSI	*Head in feet*	*Gallons per min.*	*DC Amps*	*DC Volts*	*DC Watts*
5	11.6	4.75	1.66	33.6	55.8
10	23.1	4.40	2.02	31.8	64.2
15	34.7	4.10	2.29	29.9	68.5
20	46.2	3.65	2.62	27.5	72.1



Conclusion

These pumps work great. We've been using one for years and Kathleen's gardens would be in sorry shape without it. No doubt many readers will be saying the same thing. Home Power gets a huge number of products to test every year, all claiming to be the best thing since frozen yogurt. Most of those gadgets never make it into print and some hardly get out of the box! With hundreds of pumps in operation and a track record that goes back to the early 1980s, Windy Dankoff's Solar Slowpumps™ are doing the job and doing it well. It's way past time to give this product the thumbs up and the title, Things that Work!

Access

Author: Bob-O Schultze, Electron Connection, POB 203, Hornbrook, CA 96044 • 916-475-3402

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Article Style and Length
Home Power articles can be between 350 and 6,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short (less than fifteen words) and to the point. We like the generous use of sub-headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in *Home Power*. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

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Consci Portable Power Pack

Things that Work!
tested by *Home Power*

Tested by Richard Perez

This new 12/6 Volt power pack goes far beyond the usual “battery in a box” routine. Included within the watertight, steel, ammo box is not only a battery (switch selectable for either 12 or 6 Volt operation), but also a regulator to ensure proper battery recharging from virtually any source, a 120 vac power supply to recharge from grid or inverter, a low voltage DC/DC converter that allows the box to feed 3, 6, 9 or 12 VDC appliances, a plethora or plugs/cords/adapters, and a nifty 12 VDC light with a magnetic base. This portable power pack is ideal for on-the-go operation of radios, small TVs, video cameras, notebook computers, or small (100 Watt or less) inverters.

Portable Power Pack Specifications

The pack is housed inside of a steel ammunition box with a watertight seal. The exterior dimensions of this power pack are 12 inches long, by 6 inches wide by 7.5 inches tall. The unit complete with all accessories weighs 12.5 pounds.

The Battery

The heart of C. Crane & Co.’s new power pack is two 6 Volt, 7 Ampere-hour, lead acid gel cells. These batteries can be switched in parallel to produce 14 Ampere-hours at 6 VDC, or in series to make 7 Ampere-hours at 12 VDC. This allows efficient operation of portable appliances that may require 6 Volts or less to operate. Both batteries are securely mounted inside of the ammo can. The batteries are protected against short circuits with a 10 Ampere fuse accessible from the box’s operating panel. A spare fuse is supplied and secured by a fuse holder inside the box.

Above: The Consci Portable Power Pack

The Controls

This portable power pack has user controls that select recharge mode, or 12 or 6 Volt discharge modes. A red LED indicates when the battery is being recharged. A green LED indicates that the battery has finished recharging. A yellow LED indicates that 12 Volts is available for powering appliances. This same yellow LED blinks when the battery is becoming depleted and it’s time for a recharge. The user is presented with a single switch which selects either charge or discharge mode. There are two 2.5 x 5.5 mm polarized power plugs on the dashboard, one for input, the other for output. The accessories and cords supplied with the power pack are already wired for this miniature power plug. Also supplied is a female cigar lighter socket for discharging — very handy for plugging a small 12 VDC to 120 vac inverter into the power pack.

Recharging the Power Pack

One of the best features of this power pack is its ability to recharge from virtually any power source. Supplied with the power pack is a heavy duty 120 vac to 12 VDC at 1 Ampere power supply. This supply allows recharging the pack from 120 vac from either the grid or from an inverter. Recharge time from the 120 vac supply is about eight hours. Also supplied with the pack is a 12 VDC adapter cord which allows recharging from a car or boat (this takes 1–3 hours). The pack will also accept a recharge from virtually any PV module. Since all recharging takes place through the unit’s built-in regulator, there is no possibility of damaging the battery by overcharging or by too rapid recharging. A convenient green LED lets you know when recharging is complete regardless of the charging source used.

Accessories
C. Crane & Co. supply the following accessories with every portable power pack: 120 vac recharging supply, DC/DC converter with six different types of miniature DC power plugs (for 12, 9, 6, or 3 Volt appliances), cigar lighter cord for recharging from an automotive system, a spare fuse, and a bright 12 VDC light with a slick reel-up cord and magnetic base. Everything fits into the ammo box with room to spare for a small inverter and other stuff.

Power Pack Performance
I have built many versions of the "battery in a box" for my own use. I have even written up several in Home Power. Nothing that I have ever constructed even comes close to the simplicity, ruggedness, and ease of operation of C. Crane's portable power pack. If this were a computer I would say it has a "dynamite user interface". Operation is simple and foolproof. The quality and finish of the unit is exceptional — far beyond that which any homebrewer can accomplish.

I have powered Ham radios, general coverage radio receivers, a five inch B&W television, and lighting directly from the power pack. I have also used several small inverters (PowerStar's Pocket Socket and a 100 watt Statpower) with the pack. It works great for laptop or notebook computers.

The rugged ammo box allows this power pack to be tossed in the back of a pickup truck and bounced over miles of bad road. Water, vibration, and routine abuse pose no threat to this unit. I'd pack it with me to the Andes.

The Bottom Line
The cost of C. Crane's Portable Power Pack is $134.95 which includes shipping inside the USA. Considering the quality of materials and construction, this price is a real bargain. Add to this the excellent packaging and user interface of this power pack and it is worth far more than its cost. I look at C. Crane's unit beside my homebrewed attempts and I realize that I have been wasting both my time and money trying to build portable power packs. Bob Crane and his Crew have done a better job for less money than I could do it myself. Good Work and Thumbs Up!

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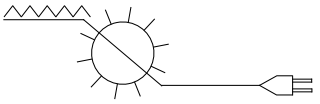

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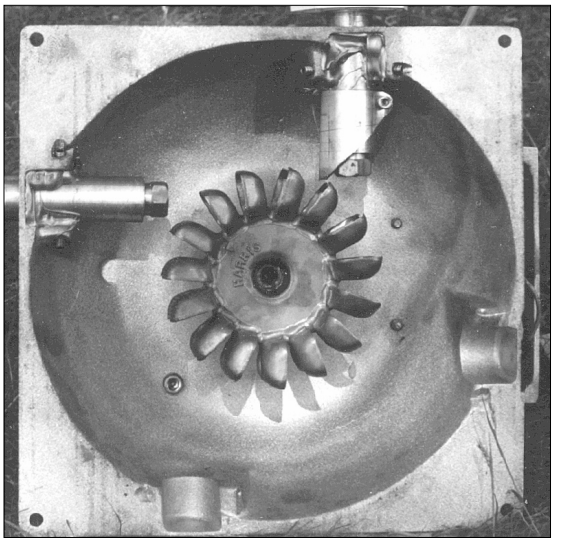

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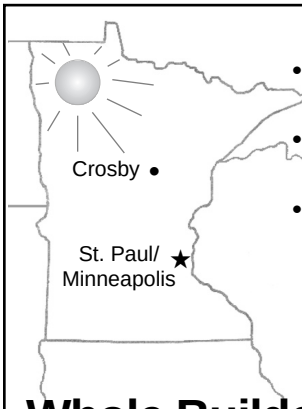

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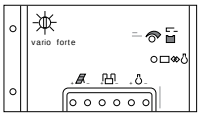

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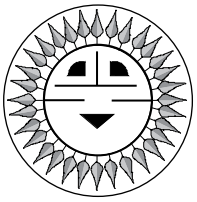

John Wiles

Disconnects in a renewable energy system allow the user to turn the system off and on, safely service the system, and shut it down quickly when it malfunctions. Properly designed and installed disconnects do not cause any performance losses in the system, but poor quality disconnects may not only cause power losses, they may also present safety hazards.

NEC Requirements

The National Electrical Code (NEC) establishes requirements for disconnects. Although the NEC may not be used in some jurisdictions, it represents a minimum set of guidelines that can be used to design and install a safe renewable energy system. Some of the NEC disconnect requirements are specifically for PV systems, but these and other requirements can be applied to any electrical power system including wind and hydro systems.

Section C of Article 690 of the NEC establishes requirements for disconnects in PV systems. All ungrounded conductors from the PV array must have a switched disconnect. If the PV system is ungrounded, this indicates that a two-pole switch must be used, one pole for each ungrounded conductor. A grounded PV system, where one of the current-carrying conductors (usually the negative) is grounded, requires only a one-pole switch in the ungrounded conductors. Switches are never put in the grounded conductors of PV systems because opening such a switch during normal operations would unground the array and possibly create an unsafe condition.

All equipment in the PV system must have disconnects in the ungrounded conductors that will allow each piece of equipment to be disconnected from all sources of power. Equipment that requires these disconnects include the charge controller, the inverter, separate low-voltage disconnect devices, and external battery chargers. The power sources include the PV array, the battery bank, a backup generator, a wind turbine, a hydro generator, and any utility connection. These disconnects are required so that the equipment listed may be removed from the system for adjustment, service, or replacement while no power is being applied.

The intent behind these NEC requirements, which would apply to any renewable energy system, is that the electronic equipment in a system is very complex and will usually require adjustment or service by special technicians who might not be familiar with electrical power systems in general. The entire system is installed by a qualified person (PV dealer/installer or electrician) who is familiar with electrical power systems. The disconnect switches allow the user or the unqualified electronic service technician to work on or remove the equipment when it is unpowered and does not present a shock or fire hazard.

The NEC requires that the disconnects be manually operable switches or circuit breakers, be readily accessible, be externally operable with no exposed live parts, indicate clearly whether they are opened or closed, and be rated for the load they will carry.

Because there is usually more than one source of power in a renewable energy source, all fuses must have disconnect switches on both ends to allow all voltages to be removed from the fuse for servicing. These disconnects do not have to be connected directly to the fuse because other disconnects in the system may serve this requirement. The need for both disconnects and overcurrent protection indicates, in many cases, that circuit breakers could be used for both functions where they meet all of the necessary performance criteria.

Section 230 of the Code establishes other requirements for disconnects. No more than six motions of the hand may be used to disconnect all sources of power from a system. A complex system may require a main PV disconnect, a main battery disconnect, a main backup generator disconnect, and a main utility disconnect. This would leave two disconnects for addition of wind and hydro energy sources.

All disconnects must be grouped together and clearly marked. This requirement generally means that the PV disconnect cannot be located on the other side of the garage from the inverter disconnect, and the battery disconnect cannot be located in another room or

building. When the sparks start to fly in an electrical power system, it must be shut down quickly. In an emergency situation, firefighters and others need to have the main disconnect switches grouped together and clearly marked.

Types and Ratings

In renewable energy systems, there are frequently both DC and ac circuits. Disconnects are usually required in both types of circuits. Disconnects may be either switches or circuit breakers, but they must be rated for the voltages and currents in the circuit in which they are used. Disconnects in the PV circuits should have a DC voltage rating that is 125% of the rated open-circuit voltage. This is a combination of NEC requirements and requirements established by Underwriters Laboratories (UL). The NEC required current rating of these switches should be 125% of the PV array short-circuit current. UL requires another 125% be added to this value for those days when snow or clouds increase the irradiance above the normal value. Disconnects in the DC circuits should have a voltage rating in excess of the maximum battery voltage (usually the equalizing voltage) and a current rating of 125% of any continuous currents plus 100% of any non-continuous current. Ac disconnects should have the normal 120 volt ac rating and current ratings to handle the circuit requirements. Electricians are familiar with the ac requirements and they will not be elaborated herein.

Implementation

The requirements outlined above, good engineering practices, equipment availability, and above all safety considerations sometimes present a confusing image of how to implement a system of disconnects. A few examples will be used to clarify the requirements. The following one-line diagrams do not show the details of overcurrent devices or grounding. Disconnect locations are shown by the box with the D. Starting with a simple direct-connected water pumping system shown in Figure 1, only one disconnect is required to separate

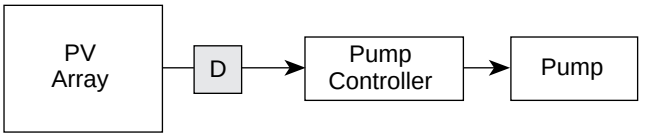

Figure 1

the PV array from the load. This disconnect is frequently a DC-rated circuit breaker mounted in a rain proof enclosure on the PV array mounting structure or PV tracker pole. Circuit breakers and enclosures are frequently more compact and less expensive than DC-rated switches.

Figure 2 shows a basic stand-alone PV system with battery storage and DC loads. A disconnect is needed

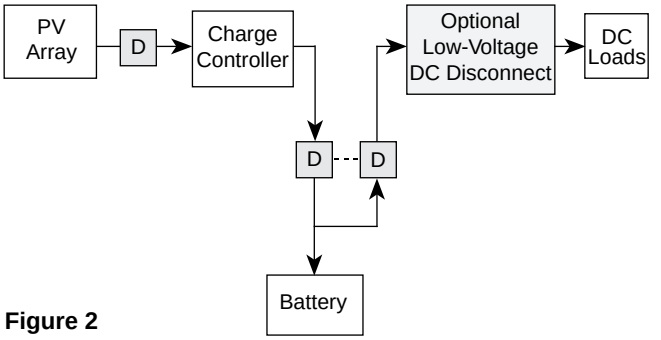

Figure 2

for the PV array, and two disconnects for the battery. The PV disconnect and the charge-circuit battery disconnect serve to isolate the charge controller should it need service.

Figure 3 shows a common stand-alone PV system with DC loads, an inverter, and ac loads. There are several ways to arrange the overcurrent devices and the

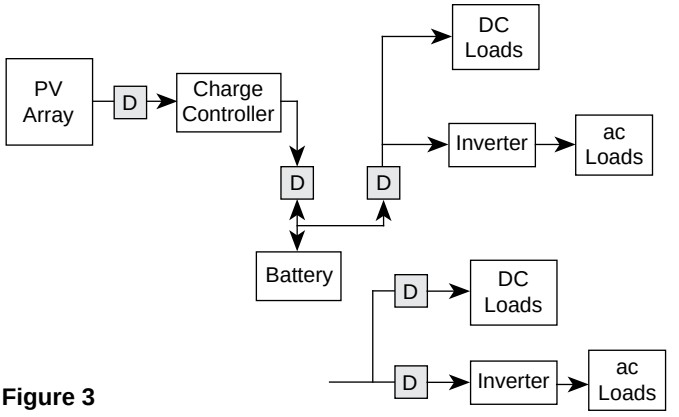

Figure 3

disconnects for the DC loads and the inverter. The lower diagram separates the disconnects for the DC loads and the inverter so that they may be operated independently. Some inspectors may require that the output of the inverter also have a disconnect.

Figure 4 adds a backup generator to the stand-alone system with a separate battery charger. An ac disconnect is needed between the generator and the battery charger and a DC disconnect is needed between the battery and the battery charger. Some of the DC disconnects could be combined, but charge

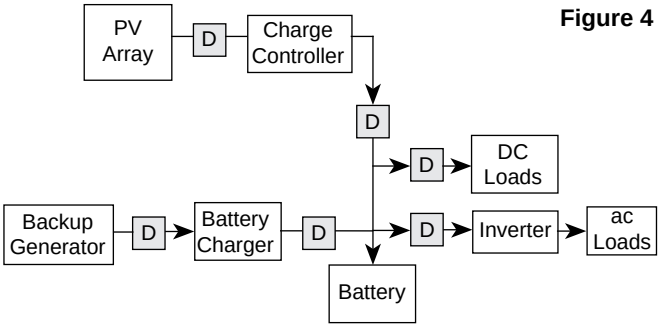

Figure 4

circuits should be kept separate from discharge circuits.

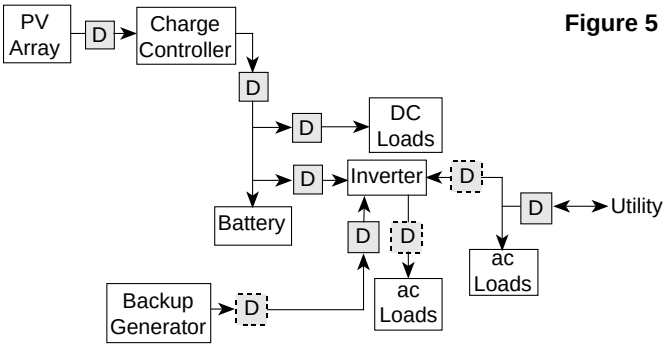

Figure 5

Figure 5 shows one of the more complex systems with an inverter with built-in charger and a utility-intertie capability. The inverter provides the transfer capability for the ac loads between the grid and the backup generator depending on what source of power is available. Excess power can be fed to the utility after appropriate contractual and safety arrangements have been made. The Trace Sinewave 4024 inverter provides all of these features. The disconnects shown in dotted boxes may be required to meet the grouping of disconnects requirement.

If the main ac service entrance disconnect for the utility is located some distance from the PV and battery disconnects, an additional ac disconnect will be needed near the inverter. Inspectors may also require an overcurrent device at this location to protect the cable when the inverter is feeding power to the grid. Since the generator is remotely located from the inverter, a disconnect will probably be needed at the generator location. This is particularly true if, as in the case of the Trace SW 4024, the inverter can feed power to the generator under certain circumstances.

The additional requirements for overcurrent devices will complicate these diagrams. Stay connected for a future Code Corner in which all of the requirements for grounding, overcurrent devices, and disconnects will be combined and shown in diagrams.

Access

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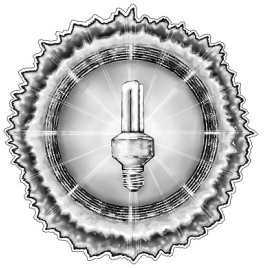

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Human Radiation Experimentation

Michael Welch

For the last several months, we've been hearing mainstream news reports about the Department of Energy and other governmental organizations that have conducted radiation experiments on humans both with and without their knowledge and consent. These experiments were horrendous. Public outrage is characterized by ordinary folks not being able to understand how are government could do such things, especially to our own citizens.

An example of these experiments was revealed by Pulitzer Prize winning journalist Eileen Welsome of the Albuquerque Tribune. Ms. Welsome's investigations turned up a list of people who were subjected to injections of plutonium in Atomic Energy Commission experiments. These folks had been admitted to hospitals for other reasons, and were then subjected to the experiments, like a railroad porter who had injured his leg when he fell off a train who was unknowingly injected with plutonium. He and his family *never* found out about it until long after his death, when Ms. Welsome uncovered the details.

The news media has assured us that these type of experiments are no longer being conducted on human beings. The public has breathed a sigh of relief that these American atrocities are finally over...or are they? Some think we are all still being experimented upon.

One who believes we are still the victims of a huge experiment is John Gofman. John is a scientist of Medical Physics, and is a thorn in the side of the nuclear weapons/power industry. His credentials are impressive, including being on the Manhattan Project team that first isolated plutonium and also a former Associate Director of the Lawrence Livermore radiation laboratory.

John's life work points out evidence that there is absolutely *no* level of radiation exposure that is safe.

What we mean by that term is 'ionizing radiation' - the gamma rays, X-rays, and beta particles which come from the natural, spontaneous disintegration of the nuclei of atoms of materials like uranium, plutonium, cesium and others. The important characteristic of this radiation is that its energy is carried through tissue by high- speed electrons, and that transfers of their energy occur along paths in an extremely localized and concentrated fashion. Unlike other poisons, such an electron cannot be diluted in effect. It cannot be subdivided to have a lesser impact on the tissue it contacts.

At one time, the Atomic Energy Commission was funding a bio-medical lab, with Gofman in charge, at the Lawrence Laboratories for the specific purpose of finding out the medical implications of human radiation exposure. Then, Gofman's work began to show that there were some serious medical problems that came with exposure, and he and his lab employees published papers and gave lectures on the subject, as any laboratory scientists would. When the nuclear industry got wind of his work, it did all it could to silence Gofman. Since the AEC had become the industry's promoter of nuclear energy, it soon put an end to Gofman's lab funding, including stopping his scientific research at Lawrence on cancer and chromosomes.

Since then, John has struck out on his own, continuing his research on the effects of radiation. We have a voice of sanity among the hardened. But John's voice is barely heard. His peers in the nuclear industry have all but silenced him by professional ostracism. Out of their fear of the truth, you'll not hear his research mentioned in DOE or NRC contracts, hearings or commissions.

And the industry is very afraid of what he has to say. They pad their ranks with so-called "scientists" who willingly ignore the harmful effects of radiation, to the exclusion of those genuinely interested in the truth. Not unlike the scientists in the tobacco industry and the foresters working for the timber industry, these people know which side their toast is buttered on. Can we expect the right things to happen when we consistently have the foxes guarding the hen houses?

Gofman once said, "My particular combination of scientific credentials is very handy in the nuclear controversies, but advanced degrees confer no special expertise in either common sense or morality. That's why many laymen are better qualified to judge nuclear power than are the so- called experts."

The Continuing Experiments
Gofman's views on radiation experimentation are:

1. "If you pollute when you *do not know* if there is any safe dose, you are performing improper experimentation on people without their informed consent."

2. "If you pollute when you *do know* that there is *no* safe dose with respect to causing deadly cancers or heritable effects, then you are committing premeditated random murder."

3. "If you pollute when you *claim* the agent is safe at 'permissible levels,' then you should be required to *demonstrate* your confidence in such safety by exposing yourself and your own children and grandchildren to the full 'permissible levels' which you expect the public to accept."

Our corporate and government leaders have placed the burden of proof on the public to show that their nuclear activities can harm us, as opposed to them being required to show that what they want to expose us to will not cause any harm. Eventually, we are able to demonstrate the harm they have caused. But, often by then, significant harm has already been done. We truly are guinea pigs in the DOE's great experiments.

A good example of this is the high amount of medical radiation exposure people received 25 to 50 years ago. During that time, it could not be proven that those levels were harmful. But now, we can show that they were harmful all along. Gofman points out that our nation currently has a very high rate of breast cancer, and scientists and the media keep searching for likely causes. But Gofman says they are ignoring the fact that ionizing radiation is the one proven cause of breast cancer.

Here is an instance whereby exposures eventually were decreased because years later we discovered the harmful effects of that exposure from the ongoing human experiment. But, as an interesting digression, scientists and the media continue trying to bury the relationship. They claim to be still searching for the likely cause of these breast cancers, when the most likely and one "proven" cause (besides heredity) is ionizing radiation. What does this say about the power and control that the corporate industry holds over our scientists and the media?

Other areas of current radiation experimentation on humans involve nuclear plant workers, uranium miners, and medical isotope manufacturing workers. Of course these folks all know there is some exposure, or, at least, are warned of the chance of exposure.

Then there are the citizens that live around nuclear power plants or other nuclear facilities. These people are the ones that the corporations spend so much time and money trying to convince that what is going on is safe. How many times have we heard, "This plant produces less than the normal background level of radiation." What they don't say is obvious (and potentially dangerous): "less than normal background level" plus normal background level equals *greater than normal background level*.

There it is: if you live by or work in a nuclear facility, or if you are being exposed to x-rays and other medical radiation, you are currently part of the human radiation experiment. In 30 to 50 years, if you get cancer or your genetically altered genes show negative effects in your offspring, you become part of the data in the experiment. In that case you will have finally proven the corporate and government scientists to be wrong. Of course, for you this is too little and too late, as you will be sick or dead.

Our media and bureaucrats that are so concerned with the ethics of past radiation experiments refuse to acknowledge and examine the experimental nature of our government and industry's current Permissible Level and Benefit vs. Cost doctrines.

Third World Nuke Plants and The Bomb
We've been hearing a lot lately about North Korea's nuclear reactors and fears that they may be diverting plutonium from the fuel rods to build nuclear weapons. It's very easy for us to get uppity over this, since we don't think it is OK for other nations to have The Bomb. Only us.

That aside, we can only blame our government and those of other industrialized nations for nuclear weapons proliferation. For many years we have been allowing the transfer of "atoms for peace" technologies to a lot of other countries. Even if the big nuclear reactor builders like G.E. and Westinghouse haven't been able to sell their wares in the U.S., they've been doing pretty well in other countries. These reactors make plutonium in the normal course of their operation. And plutonium makes bombs.

This puts our government at cross purposes to itself. At the same time we are encouraging third world nuke power plants, we are trying to stop nuclear weapons proliferation. To further exacerbate the problem, our government has been unable to accept shipment of spent (irradiated) fuel from foreign nuke plants and experimental reactors since the 1980s.

According to a recent General Accounting Office report, foreign nuke operators are facing irradiated fuel

storage problems. We promised these facilities that we would take back their fuel so we wouldn't have to worry about the security issue of having so much bomb-making material scattered around the world.

Although our own nuclear plant fuel storage facilities are filling up for lack of a permanent repository, the foreign fuel is a greater security risk. But what are we going to do with it? There are folks that believe that a permanent repository will never be built in the U.S., which could cause our own security problems. Yet there is no doubt the world is safer with the fuel in the U.S. than if it is sitting in less secure countries.

Nuclear Regulatory Commissioners Needed

One of the greatest roadblocks to a renewable energy future has been the nuclear industry's incessant efforts to stuff their obsolete and dangerous technologies down the public throat. NRC efforts lately have centered on eliminating public participation in hearings over the siting and safety of individual plants. The revolving door syndrome of people moving from the nuclear industry into NRC Commissioner vacancies has all but guaranteed that the industry gets its way.

According to Citizen's Awareness Network, the NRC is allowing the removal of radioactive structures and components from the shutdown Yankee Rowe reactor without environmental assessment or approval of a final decommissioning plan. Other plants no longer operating have also applied for permission to do the same thing, which they are innocuously calling "Early Component Removal". This is still another abuse of NRC privilege that could result in unnecessary radiation exposure to workers and the environment.

The NRC is supposed to be a watchdog over the industry. Wouldn't it be great if there were folks on the Commission that would do its intended job?

There are currently two openings on the NRC, and it is President Clinton's duty to fill the positions. Write Clinton and suggest to him that there needs to be experts on the NRC who are willing to protect the health and safety of the public and the environment, and who are willing to place the importance of citizen participation above nuclear industry financial interests.

Some possible names for nomination were suggested by Mothers for Peace, a group long working on Diablo Canyon Nuclear Power Plant issues. The list includes Robert Pollard, of the Union of Concerned Scientists, Charles Bechoeffer, an Administrative Law Judge from the NRC's Atomic Safety and Licensing Board who is thought of as being fair, and David Freeman, who turned the Sacramento Municipal Utility District's ill-fated nuclear program into one of the U.S.'s most successful renewable energy and conservation programs. Any of these folks would go a long way toward restoring the public's lost faith in the NRC.

Access

Author: Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95521. (707)822-7884 voice, (707)822-8640 computer BBS

John Gofman, c/o Committee for Nuclear Responsibility, PO Box 421993, San Francisco, CA 94142

Mothers for Peace, 931 West St., San Luis Obispo, CA 93401 (805)773-3881.

Citizens Awareness Network, RR1 Box 83, Shelburne Falls, MA 01370

For a copy of the Eileen Welsome's Pulitzer Prize winning series on human radiation experimentation, send $1 per copy to: The Albuquerque Tribune, PO Drawer T, Albuquerque, NM 87103

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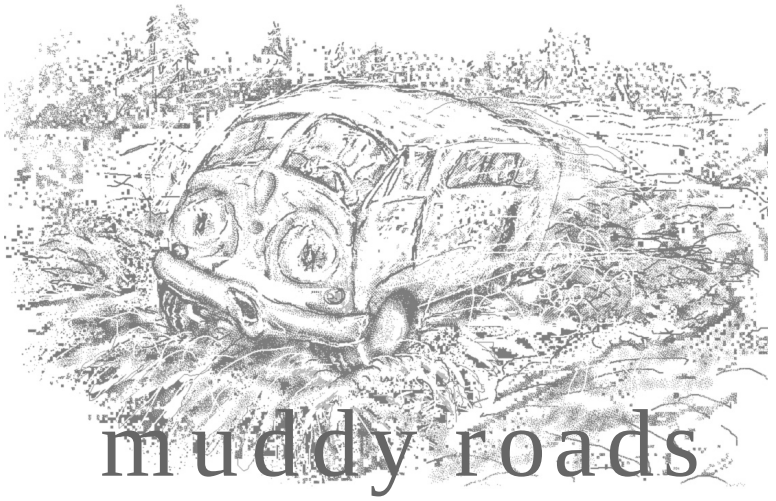


muddy roads

Dan Lepinski

We had a bit of excitement a while back, but not the kind that's any fun. We had just purchased this home, and it needed a lot of improvement — especially the wiring. That's where things began to get interesting...

It started about 11 PM, after we'd gone to bed (of course). Val, my wife, had been up to get a drink of water. On her return upstairs, she woke me to tell me that the water was running very slowly. Groggy as I was, I managed to stagger downstairs and check. Sure enough, barely a trickle of water flowed from the faucet. I tried the faucet in the bathroom. No water at all. By then, I was about half awake and able to think, but just a little. I went back upstairs, grabbed my robe, and stumbled down to the basement.

One glance at the gauge on the pressure tank said it all — it was down to less than five pounds. I went over to the funky wiring on the pressure pump and saw that the old screw–in fuse was blown. I put my meter in line on the ten amp scale and I could hear the faint hum of the pressure pump as it came to life. It's located in the well pit in the garage about 15 feet away from the point where I was standing. I had the "ah ha!" experience when one thinks that the exact cause of the problem has been discovered. Looking around, I found a replacement fuse and screwed it in. The pump hummed contentedly. Thinking all was well, I started to walk away. Before I reached the steps, I heard the loud gurgle of air as it snaked its way through the pipes and into the pressure tank. As I turned off the pressure pump, I knew the ordeal wasn't over. It meant that the underground water tank was empty — all 1500 gallons of it. It also meant that the submersible pump hadn't been doing its job. The old sub pump had been replaced with a new pump just before we moved in and I figured that the new pump had suffered a warranty failure. I decided that as long as I was up, I better check it just in case. I put on several layers for warmth (it was -22° F that night) and headed for the door.

Since I was in the process of rewiring the house, the garage lights weren't reconnected yet so I grabbed a flashlight. I also took a handheld radio in anticipation of talking to Val as we diagnosed the failure. Grabbing a few tools and my trusty meter, I took a final deep breath of warm air and plunged into the frigid darkness. After freeing the garage door from the snow, I walked through the obstacle course of unpacked belongings, weaving my way toward the well pit on the far north side of the garage.

The pit is rectangular, about four feet by five feet in size, and almost eight feet deep. It's covered with several different layers of material, all of which are intended to keep the pipes from freezing. The first layer, a large piece of carpet, came up easily. The second layer, a thin piece of plywood covered with tile was no trouble either. The third layer, a 3/4 inch piece of plywood with 2 x 4 reinforcing was frozen solid to the concrete. Condensation from the well pit had locked the edges to the sub-zero concrete, and I couldn't budge it. A large crane couldn't have pulled it loose. Val had joined me by then and I sent her back into the house to get a large pry bar. It worked.

Moments later, I was in the bottom of the pit trying to decipher the mass of wires. They were all different types and colors which were securely bound with black electrician's tape. It's amazing how hard and brittle black tape can get in such cold weather. Removing my gloves, and with the help of my wire cutters, the tape quickly fell away from the wires. I was aided in the removal effort by my shivering, which actually made the cutting go faster. By the time I had the wires exposed, Val had gone back into the house and was standing next to the switch for the pumps. You see, both pumps are fed by the same switch and fuse arrangement. Dumb, but consistent with the rest of the house wiring, and one of the reasons I was rewiring.

Talking to Val on the radio, I told her to turn the pumps on. The pressure pump whirred nicely, but no sound from the sub pump. I disconnected the pressure pump wires. A walnut sized clump of black tape hid the connections to the sub pump. More peeling and shivering and the joints were visible. Grabbing the voltmeter, I asked her to turn on the pump switch once more. I got the "ah ha!" experience again. I had voltage

to the pressure pump but *nothing* on the wires to the sub pump. I quickly connected the sub pump wires to the pressure pump wires, and it buzzed to life. Great! We had water! Yuk! Now it meant that the on/off float switch in the underground tank must have failed. It would have to wait until morning. Since the little Lowther pump only runs about two GPM, I left it running. At least we'd have water in the morning.

Next morning (–31°F) I went outside to effect repairs. First, I had to go behind the house and remove the cover from the underground water tank. After shoveling off two feet of snow, the ground-level lid was visible. I then discovered that this lid was even more securely frozen than the one in the garage the night before. After half an hour of banging, prying, and bad words, I had the lid freed from the opening above the tank. Reaching down into the three foot diameter access hole, I removed the layer of insulation covering the tank itself. In spite of multiple layers of clothing, two ski caps, gloves, and a very large mug of hot chocolate, I was freezing, but determined to finish the job. I climbed into the access hole. I could hear water running into the tank. Nuts! I'd forgotten about my temporary wiring job from the night before. The sub pump was still running. Grrrrr! Back to the garage and into the pit to undo the makeshift wiring. The lid was frozen to the floor again. @#$%!! More banging and prying. My hands hurt. My toes hurt. My fingers wouldn't move. But my determination was stronger than the ice and I finally had the lid removed. With the wiring back to normal, I trudged back out into the snow and toward the underground tank. Back into the access hole, I connected my ohmmeter and checked the switch. It read good. Something must be wrong. I checked again. Nope. The switch was fine. Now what? A broken wire? A bad connection? Hmmmm... I climbed out of the access hole and reinstalled the covers, making sure the top cover had a good layer of insulating snow on it. I pushed my numb body back into the warmth of the house and down to the basement.

I needed to think. As I put the meter on the bench, Val pointed to a single wire with a piece of duct tape with a "+" marked on it. "Is that wire anything important?" she asked. I'd removed it while rewiring, but unlike all the other wires I'd removed, this one had no mate. I found numerous wires that were disconnected. I had a sudden flash of inspiration. I switched the meter to read amps. Connecting one meter lead to the wire and the other lead to the battery positive, I read current! Two amps! This was the lead to the submersible pump in the well! Why no negative lead? It shared the negative lead with the pressure pump. Ah ha! I quickly slipped the odd wire into the metal block with the other positive leads and tightened the retaining screw. As I pushed the metal block back into its temporary location, I noted with a bit of regret that this simple connection was less than a foot from where I'd replaced the fuse the night before. Rewiring the house was going to be fun...

Access
Dan Lepinski, Rt 1 Box 268A, Exeland, WI 54835

M.R.E.A. 1994 Summer & Fall Workshop Series

The 1994 Energy Fair is over but the information and educational services provided by the MREA's Educational Institute continues. This summer and fall, in-depth workshops will offer hands-on experience to those interested in the nuts and bolts of renewables and energy efficiency. For more info, call or write the

Midwest Renewable Energy Association,

PO Box 249, Amherst, WI 54406 • 715-824-5166

Photovoltaic Powered Home Systems — August 13 & 14 — Jim Kerbel, Photovoltaic Systems. Amherst, WI (Workshop located in Amherst, WI) Jim has been a pioneer in photovoltaics and his work has been instrumental in the growth and development of photovoltaic throughout the Midwest. Jim's involvement in PV from the "very early days" brings a wide angle perspective to his presentation. This course deals with photovoltaics for stand-alone systems, but also touches on utility inter-tie systems as the "next generation" of photovoltaics. It covers siting and design, system sizing, charge controllers, batteries, inverters, and wiring and installation methods. The site is powered by a PV system which offers the class practical examples and hands-on education. Cost $200.

Home Sized Wind Systems — August 26 & 27 — Mick Sagrillo, Lake Michigan Wind & Sun. Forestville, WI. (Workshop located in Forestville, WI) Mick is a manufacturer of wind electric components and rotors for Jacobs and others, as well as designer and installer of wind systems. Mick is also widely recognized as an authority, writer, consultant, and instructor on the subject of wind machines, rotors, and tower designs. The course covers siting and design choices, system sizing, machine and rotor types, governing ,methods, tower designs, charge controllers, wiring and installation methods.Stand-alone systems, as well as utility inter-ties are discussed. Hands-on projects and demonstrations enhance the learning experience. Cost $200. Registration deadline is August 15, with a $50 non-refundable registration fee.

Window Quilting for Moveable Insulation — September 10 — Beverly Nelson. Stevens Point, WI (Workshop located in Stevens Point, WI) Bev has been sitting at her sewing machine for more years than she cares to mention. In more recent years, she has adapted her quilting skills to window treatments. This workshop addresses window treatments (insulation) for residential applications. The course focuses on making "Warm Windows" window quilts, as used in the Energy Fair's model home. Quilts in various stages of completion will be on display to demonstrate construction methods. Cost $75. Registration deadline is September 1, with a $25 non-refundable registration fee.

Residential Solar Domestic Hot Water — September 17 — Richard Lane, Packerland Solar. Green Bay, WI. (Workshop located in Green Bay, WI) Packerland Solar is the largest solar hot water installer in the world. The workshop discusses the various aspects of residential solar domestic hot water. Siting, system types, sizing, system components, transfer fluids, controllers, and installation methods are discussed.Hands-on demonstrations enhance the learning experience. Cost $100. Registration deadline is September 5, with a $25 non-refundable registration fee.

Wind/Photovoltaic Hybrids —September 23 & 24 — Mick Sagrillo, Lake Michigan Wind & Sun, Forestville ,WI and Jim Kerbel, Photovoltaic Systems. Amherst, WI (Workshop located in Amherst, WI) Jim and Mick are experts in wind and photovoltaics, experienced in hybrid systems, and tenured educators. This course delves into the matrimony of wind and sun. It covers siting and design choices, "Demand Side" mathematics, system sizing and balance, charge controllers, high voltage transmission, tower designs, wiring and installation methods, and more. The site has a wind/pv hybrid system offering hands-on projects and demonstrations. Additional wind/PV hybrid systems in the area may be visited. Cost $200. Registration deadline is September 12, with a $50 non-refundable registration fee.

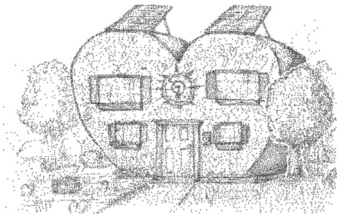
Batteries and Inverters, applications for home-sized systems —September 30 – October 2 — Richard Perez, Home Power Magazine, Ashland, OR. (Workshop located in Tomahawk, WI) Richard is well known throughout the RE industry. Richard has written extensively on the subject of batteries and inverters, as well as photovoltaics. Friday evening: introductions, evening meal and networking. Saturday: Batteries, an in-depth look at battery types and chemistry, reconditioning, characteristics and performances, battery use/specific applications, installations and maintenance, and safety. Sunday: an in-depth look at inverters including sine wave (stand-alone and synchronous), modified sine wave, square wave, study of "switchers" and transformer based types, size/application, operating characteristics, internal protections, specific applications, noise and RF & EMF, and inverter/battery & inverter/mains connections. Lots of demonstrations and comparisons with batteries, inverters and test equipment provided. The Treehaven Learning Center is a wonderful facility complete with a cafeteria, recreation room, and miles of hiking trails in Wisconsin's north woods. Cost $250. Registration deadline is September 12, with a $50 non-refundable registration fee.

How to Build an Affordable Natural House Using Timber Frame, straw/clay, earth plaster, & earth floor — October 14 –17 — Robert Laporte, Natural House building Center, Fairfield, IA. (Workshop located in Amherst, WI) Robert is the owner of Natural House Building Company and writer of Moose Prints, A Holistic Home Building Guide. He has conducted workshops detailing natural home building methods throughout the country. This workshop brings together four natural house construction methods: timber framing with info on the plan design, layout, cutting, assembly, and rising. Straw/clay building with info on materials, tools, clay types, ecological harvesting, clay slip recipes, and straw clay roofs. Earth plastering, including info on tools and materials, plaster recipes, and applications. Earth coupled construction discussing the base, screen, sub-floor, earth floor, stone floor, and mortared floor. A class project will give everyone hands-on experience. Cost $400. Registration deadline is October 1, with a $50 non-refundable registration fee.

Residential Solar Energy: Doug Steege — October 22 — Altech Energy. Madison, WI. (Workshop located in Madison, WI) Doug, a co-owner of Altech, has long been an educator, writer and renewable energy advocate. Doug brings his historical perspective to this workshop. This workshop covers solar heating and home design. Included in the course: The historical perspective, active solar systems, passive solar systems, collection and storage systems, conservation and insulation, air to air heat exchangers, moisture barriers, and discussion on the future of solar energy. Cost $100. Registration deadline is October 10, with a $25 non-refundable registration fee.

Introduction To Renewables —November 11–13 — Mick Wurl-Koth, Solar Spectrum. Tomahawk, WI. (Workshop located at Treehaven Learning Center, Tomahawk, WI) MIckey has been a long time advocate and educator on solar and renewable energy. Mickey and his wife Julie are the co-owners of Solar Spectrum, a solar energy business in Northern Wisconsin. The workshop covers a wide spectrum of renewables — photovoltaics, wind, passive solar, solar hot water, etc., and includes a field trip to the passive solar designed Wurl-Koth home, complete with a working wind generator on a tilt-up 100 ft. tower, photovoltaic system, solar hot water system, and cookies from the home's solar ovens. The Treehaven Learning Center is a wonderful facility complete with a cafeteria, recreation room, and miles of hiking trails in Wisconsin's north woods. Cost $250. Registration deadline is November 1, with a $50 non-refundable registration fee.

Home & Heart



Kathleen Jarschke-Schultze

There is a lot of reference material out there on making your home and your lifestyle ecologically safe. There are books on providing your family with good nutrition cheaply and with the least amount of hassle. These are some of the books and videos I have had the pleasure of reviewing.

A Bite of Independence

This book, written by Marlynn, Venecia and Jenny Phipps and Jan Woolley, will teach you how to: "Feed a Family of Four for as Low as $10 per Week". I really enjoyed reading this book. Not only is it full of good practical information but also interesting and whimsical formulas (making your own cosmetics).

It's a System

To get the full benefits of this system of shopping, cooking, and eating you will need to supply your larder and kitchen with various ingredients and cookware. Once you are set up though, watch out and stand back. The keys to this system are preplanning and simplification. Jenny Phipps, who is 16, spent two and a half hours in the kitchen and prepared 21 separate meals (one weeks worth). Sure, she was trained by her mother, Marlynn, from an early age but this book gives you the recipes she used and the sequence of her preparations to show you exactly how it can be done.

There is an extensive amount of information on making and using wheat meat, gluten, or seitan. It is all the same thing. You can make it from flour and water and disguise it to look and taste like meat or seafood. Dedicated carnivores that I know personally even like it. This is the basis for your low cost meals.

The Rest

There are 22 chapters covering stocking your kitchen to beekeeping, fish farming, home butchering, gardening, making your own makeup and more.

Included are cleaning preparations, laundry soaps, seasoning mixes and charts, helpful tips and recipes too difficult to classify.

This is the kind of knowledge that was passed from generation to generation back when 80% of America lived on farms. A lot of ingenuity went into this book and it shows the authors as genuine people.

The Encyclopedia of Country Living

For anyone who has an earlier edition of Carla Emery's classic back-to-the-earth book all I need to say is that a new ninth edition came out this year. For those of you who don't know what that means let me introduce you.

Carla, Herself

This is one person to whom I have composed fan letters in my head, for the last 17 years. I've never had the nerve to actually send any. I admire her a great deal. I first saw a copy of Carla's *Encyclopedia* at a friend's house. My friend had lived in Kendrick, Idaho and had gone to the same church as Carla. Hers was hard bound, dark blue with binder rings so that more chapters could be added later. I borrowed the book. I was fascinated. Carla talked about living the life I wanted to live. I bought a copy. Her history, and the book's, are sprinkled throughout. You actually get to peek into Carla's life and see just how she copes with all the interesting, tragic, joyful, curious events that seem to follow her path. The only reason Bob-O deemed me "marginally mountain" after our marriage was that I was able to fake it pretty good using this book.

An Old Fashioned Recipe Book

If I had to choose five reference books to keep, this would be one. I have a well thumbed, yellowing seventh edition that boasts 529 pages. This newly released ninth edition has 858. The print is smaller and the printing and binding is a lot classier. She has amassed a lot more information. The access information is up to date.

Mine was the book I used when I was in my poultry phase and my goat phase. It helped me when I started gardening. I used it for canning, for drying jerky, for making soap, candles, just about everything. It really is an encyclopedia. It gives you real hands-on directions for skills to live a simple, rural, or remote life. The ninth edition is just as great — only more of it.

I was kind of disappointed that *Home Power* wasn't mentioned and renewable energy in general got the lightest touch. There is some good access in there though so its okay. I guess now I will write that letter and send her an issue of *HP*.

Creating a Healthy Home

This 25 minute video is an ecological tour of an on grid home. A young mother points out the many chemicals that are in a typical home. She uncovers causes and

remedies to help you to go through the process of changing your home into a toxic free environment. I knew most of the stuff on the video but still got some new info from it. It is well done if obviously low budget. It could be just the thing for teachers or service groups. It's produced by Midway Environmental Videos.

Co-dependent Ecology
Again 25 minutes long, your guide in this one is 13 year old Billy Wilson, who shows you room by room how easy it is to save energy and money while conserving our natural resources. This is also an on grid home. A lot of the methods don't apply to AE homes. The kid is more personable than the young mother and I did learn a few things. Also by Midway Environmental Videos.

Access
Kathleen Jarschke-Schultze reads and weeds at home in northern most California c/o Home Power Magazine, POB 520, Ashland, OR 97520 • 916-475-0830

A Bite of Independence: $30. (AZ residents add $1.75 tax), send check written to Marlynn Phipps to 2162 E. Nantuckett Drive, Gilbert, AZ 85234

The Encyclopedia of Country Living: $24.95, 11" by 8 1/2" by 1 1/2", paperback from Sasquatch Books, 1008 Western Ave, Ste 300, Seattle, WA 98104 • 800-775-0817 or $28.50 from Carla's Office, Box 209, Kendrick, ID 83537

Co-dependent Ecology and *Creating a Healthy Home*: $24.95 each, from Midway Environmental Videos, 2175 Goodyear Ave, Ste 124, Ventura, CA 93003 • 800-446-4997 • FAX 805-6441361

HAPPENINGS

INTERNATIONAL

AFRICA

The ISES 1995 Solar World Congress that will be held September 9–16, 1995 in Harare, Zimbabwe, Africa has announced its call for papers. Topics include solar radiation, photovoltaics, solar water and thermal applications, storage , wind , micro-hydro, education, etc. Abstracts, prepared in English, are due not later than November 1, 1994. For more information contact, In Search of the Sun (PVT) Ltd, PO Box 2851, Harare, Zimbabwe, Africa, telephone 263 (4) 730707, fax 263 (4) 730700, telex 26623 ZW (MACDEE)

BOLIVIA

The Seminario Internacional De Energias Renovables will be held September 20–22, 1994 in Santa Cruz, Bolivia, South America. The objective is the exchange of information and experiences in the appropriate technology field between researchers, suppliers, installer, and users of appropriate systems. Topics will include planning energy development; application of micro-hydro, wind biomass, & solar; developing new technologies; evaluating RE resources; economic analysis & promotion; and other related subjects. For more information please contact: PROPER, Casilla 2672, Cochebamba, Bolivia, South America; phone 591-42-50327, fax 591-42-49649.

CANADA

Are you now operating diesel or gas generators with their high fuel and maintenance costs, or just doing without electricity. Have you ever wondered about energy available in falling water? This course will tell you how to determine the feasibility and cost-effectiveness of a low maintenance waterpower option (not necessarily nearby). Neither solar PV nor windpower can come close to competing with this technology.

These two day, twelve hour micro-hydro courses are suitable for everyone, regardless of technical background. The course includes an overview of electricity & energy and terms & concepts. Upon completion, you will be able to assess the potential of your stream or creek to meet your electrical needs. Learn how to size system components,estimate costs, and have some basic installation guidelines. The cost of each two day course is $80 Canadian (approximately $57 US). September 24 & 25, 1994, Selkirk College, Nelson , BC V1L 1C8, 604-352-6601 or October 22 & 23, 1994, University College of the Cariboo, Kamloops, BC V2C 5N3, 604-828-5039. For more course information contact Bob Mathews, course instructor, at 604-679-8589. Field trips and other course dates will be scheduled as demand requires.

FRANCE

The European Conference on Energy Performance and Indoor Climate in Buildings will be held Nov. 24–26 1994 in Lyons, France. Its aims are to discuss the results from research and development in solar energy applications and the rational energy use in buildings, to confront the views and needs of industry and professionals, to inform the European building community on the latest developments in the research and application of new building products and evaluation of tools and to discuss the possibilities for standardization of assessment methods and energy performance requirements on a European-wide level. The oral sessions will be in English and French. For more information contact, Ecole Nationale des Travaux Publics de L'Etat, Rue Maurice Audin, 69518 Vaulx en Cedex, phone 33-72047070, fax 33-72046254, telex ENTPE 370511F

GERMANY

The 27th Annual ISATA International Dedicated Conference on Electric, Hybrid & Alternative Fuel Vehicles will be held October 31–November 1 1994 in Aachen, Germany. The conference will focus on the most pressing questions in the world of Electric, Hybrid and Alternative Fuel Vehicles. For more information contact ISATA Secretariat, 42 LLoyd Park Ave, Croydon, CR0 5SB, England, 081-681-3069 Fax 081-686-1490

NATIONAL

American Hydrogen Association Bulletin Board System: Solar Hydrogen BBS, 415-494-3116, 1200–14,400 baud V.32bis. V.42bis 8N1, Prosperity without Pollution: also AHA Tempe BBS (602) 894-8403.

The DOEs Energy Efficiency & Renewable Energy Clearinghouse has a new free factsheet, "A Guide to Making Energy Smart Purchases" (FS113). Call 1-800 DOE-EREC, 9 am–7 pm EST.

2nd National Tour of Independent Homes, sponsored by Real Goods Trading Corp. October 15, 1994, 10AM–4PM. Call 1-800-762-7325 for information on alternatively powered homes available to tour near you.

ARIZONA

World Unity Festival, August 22–28, 1994, Flagstaff. The Festival celebrates global oneness, generates environmental awareness, shares cultural wisdom and honors the Earth's diversity. Contact: Quetzalcoatl Productions, 4 San Francisco St #438, Flagstaff, AZ 86001 • 602-773-9669

CALIFORNIA

Siemens Solar Industries is offering its 1994 five day Photovoltaic Technology and System Design Training Course. Learning begins by purchasing the two volume set of Training Manual and Technical Appendix for $175. The fee includes the 30 minute videotape "The World of Solar Electricity". Step two is a five day training class. The next class will be held September 19–23 at the Siemens Solar Training Center, Camarillo, CA. The training class, including the two set manual & video is $1500 (food and lodging not included). The course offers experimentation with inverters, controllers, batteries, modules, trackers and loads. The "final exam" is a full system design. Contact the Training Department of Siemens Solar Industries for a Course Information Package and application form. Call Cindy Vernon • 805-388-6568 • fax 805-388-6395.

Offline Independent Energy Systems is offering a one day workshop Sunday, October 2, 1994. A basic first step course in understanding how a residential PV system works will take place at Sun Mtn., a ten year old integrated passive solar home with one of the first PV systems in California, located in Tollhouse, CA, one hour from Fresno. The class begins with a brief tour and discussion of the Sun Mtn. system: Basic system types, determining your power needs, living with PV (conservation, efficient appliances), load audit, sizing the PV array, batteries, inverters, load centers, putting it all together and estimating costs. The workshop costs $35 for one person or $45 for two coming together. For more information and directions write: Offline, PO Box 231, North Fork, CA 93643 or call 209-877-7080.

COLORADO

Solar Energy International (SEI) is offering workshops on the practical use of solar, wind, and water power. The 1994 Renewable Energy Education Program (REEP) features one and two week workshops: Solar Home Design Principles, Alternative Building Technologies & Passive Solar, Women's Basic Carpentry, Solar Water Pumping, PV Design & Installation, Advanced PV, Solar Cooking, Drying & Water Distilling, micro-hydroelectric systems, alternative transportation & EV Conversions, Hydrogen Energy. Guest speakers and professional instructors will teach the design of state-of-the-art solar homes that are self-reliant, energy efficient, healthy to live in, and earth-friendly. Participants will learn the knowledge and skills to build energy independent homes with solar, wind, and water power. The series is for owner-builders, industry technicians, business owners, career seekers, and those working in developing countries. The workshops may be taken individually or as part of a program. The cost is $400 per week. Scholarships and work/study programs are available on a limited basis. Contact: Solar Energy International, PO Box 715, Carbondale, CO 81623-0715 or call 303-963-8855.

The Crestone Energy Fair will be September 10–11, 1994. The usual fun — great solar-powered music, delicious solar baked food, and the gathering of the solar tribe for council. Contact Kenny Dessain, Turtle Island Peace Camp, PO Box 222, Crestone, CO 81131.

The 3rd Annual Boulder "New Renaissance" Festival will be held Sept. 3–5, 1994 in Boulder, Colorado. A future oriented community event whose focus is on creativity, art, education , health and wellness, and a strong emphasis on the environment and appropriate technology. This year's festival will spotlight technology for building a sustainable society with expanded emphasis on renewable energy. TIMEWEAVE, the educational non-profit group producing the festival, is working with Citizens for Clean Energy to design the Solar Electric Carnival, an interactive educational exposition of renewable energy technology. After the 1994 Festival this display will become a mobile educational exhibit, available for schools and other public events. Planned events also include media and policy maker's days for EVs, an electrathon race, a 10K WalkAbout# and a hybrid electric/HPV challenge. The Festival is seeking participation from individuals, groups and industry. To participate or exhibit, contact Steve Clark, TIMEWEAVE/BNRF '94, PO Box 348, Boulder, CO 80306-0348 • 303-939-8463

FLORIDA
The 1994 ARRL 19th Annual Amateur Radio & Computer Convention will be held November 19 & 20, 1994 in Tampa, Florida. For more information contact FL Gulf Coast Amateur Radio Council, PO Box 2423, Clearwater, FL 34617-2423 or call Bill Smith 813-837-4533.

IDAHO
Backwoods Solar Electric Systems will hold a Saturday workshop, September 3, 1994 on photovoltaic theory, equipment and installation. Limited to ten people. Non-refundable, pre-registration of $40 covers class, lunch and text book, or $30 per person for couples sharing the book. Contact Backwoods Solar Electric, 8530 Rapid Lightning Creek RD, Sandpoint, ID 83864, 208-263-4290.

IOWA
The Third Annual Iowa Renewable Energy Expo & Alternative Fuel Vehicle Showcase will be held September 10–11, 1994 at Hawkeye Downs, Cedar Rapids, IA. The Expo will feature: Entertainment, Speakers, Kids Activities, Demonstrations, Workshops & Displays of small-scale & utility wind systems; active solar heating; PV systems & water pumping; energy & sustainable agriculture; conservation; energy efficient architecture; hydrogen, soy diesel, natural gas, solar powered & conversion vehicles; basic electric, batteries, inverters; utility issues and more. Contact Iowa Renewable Energy Assn., 611 Second St SE, Dyersville IA 52040 • 319-875-8772 or Stan Eilers, 319-365-7314 or Tom Deves, 319-556-4765.

MASSACHUSETTS
11th Annual Quality Building Conference '94 — Making Sustainable Building Standard Practice: November 11–12, 1994 in Springfield. Expert builders will present practical, cost effective applications of the latest advances in energy efficient, sustainable design and construction, indoor air quality, and building science. QBC'94 will take a comprehensive look at the people, economics and practices which are changing the way we think about and construct buildings. Workshops, technical presentations, demonstrations and a design competition will underscore the close connections between energy efficiency, sound business growth and environmental responsibility. In depth workshops will feature the Energy Crafted Home, Waste Reduction and Recycling and other topics. For more information contact NESEA, 23 Ames St, Greenfield, MA 01301 • 413-774-6051 • fax 413-774-6053

MICHIGAN
The 4th Annual Great Lakes Renewable Energy Fair will be held August 6 & 7, 1994 in Traverse City. Demonstrations, workshops, speakers, display booths, children's activities, food, solar panels, windmills, electric cars & boats, a bus tour of local RE homes & biomass will be covered. For more information contact GLREA, 11059 Bright Rd, Maple City, MI 49664, 616-228-7159

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516.

OHIO
Solar electric classes taught at a rural solar and wind powered home with utility backup. Maximum of 12 students. Must advance register. $30 fee per person and lunch is provided. Class will be full of technical info, system sizing, NEC compliance, etc. Students will build a system. Dates: August 20 & September 17. All classes held from 10 am to 2 pm on Saturday. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perryville, OH 44864-9537.

OREGON
Oregon SunWorks '94, August 20–21 in sunny downtown Portland,OR. A two day conference merging the best ideas of the 70' with state-of-the-art solar technology of the 90's. Exhibitors, electric car rally, solar cooker chili cook-off, kid's camp, guest speakers, advanced seminars, solar home tours, and all day workshops. For more information contact SEA at 503-224-7867

RHODE ISLAND
The Sustainable Transportation and Solar and Electric Vehicle (S/EV94), October 3–5, 1994, will be held at the Rhode Island Convention Center in Providence. The show provides transportation planners, auto, bus and train industry personnel, business people, fleet owners and operators, students and concerned citizens a forum to exchange information on EV technology, policy, and business, as well as transportation planning strategies to create a non-polluting, equitable and efficient multi-model transportation system. For more info contact: NESEA, 413-774-6051.

VERMONT
"Photovoltaic Home Electric Systems: Seminar and Workshop" is a one day program, held at Sunnyside Solar in Guilford. The 1994 dates are July 30 and Sept 24. Each program runs from 9 am to 4:30 pm with lunch included. This introduction to independent solar electric systems includes the hands-on assembly of a four module system. The fee is $135 with a companion registration available for $95. A $45 advance deposit is required, balance due the day of the seminar. Each session is limited to the first ten deposits. Included in the fee is a full packet of information & related articles, Joel Davidson's The New Solar Electric Home and Steven Strong's The Solar Electric House. Sunnyside Solar offers this seminar and workshop to those interested in photovoltaic and its use, particularly in residential application. For information & registration contact, Carol Levin, Sunnyside Solar, RD4 Box 808, Brattleboro, VT 05301.

WASHINGTON
Rides Publishing Company is offering two day seminars for marine electrical installers at various dates in 1994. The seminars are intended to solve the #1 problem with boat electric today... lack of accurate knowledge about batteries, alternators, chargers, inverters, regulators and instrumentation. In depth and general information about electrical systems will be presented. Seminars will be held at selected cities. Participants will learn from David Smead, principle author of Living on 12 Volts with Ample Power and Wiring 12 Volts with Ample Power and engineer for Ample Power Products. To learn more about the training seminars, locations, and dates, and costs contact Rides Publishing Company at 206-789-5758, Fax 206-789-9003

WISCONSIN
The Midwest Renewable Energy Association will be holding an on-going series of workshops. (see page 95 of this issue). For more information call or write the Midwest Renewable Energy Association, PO Box 249, Amherst, WI 54406, 715-824-5166.

the Wizard speaks…

The Zero-Point Field

The vacuum of space is said to be empty. This is not quite true. Space contains the electro-static, magneto-static, electromagnetic, and gravitational fields created by all the particles in the universe. This vacuum field of space has two components. The first component is the normal set of measurable fields. The second is the zero-potential or zero-point field (ZPF). This is that part of the vacuum field in which all the force vector components cancel each other but the energy potential remains, Can this energy be tapped?

Fluctuations are caused in the ZPF by fluctuations in the motions of the particles that create it. These fluctuations cause the emission of energy from the ZPF in the form of virtual photons. Virtual photons are packets of energy similar to regular photons.

Much research and experimentation is occurring in an attempt to harness the energy of these ZPF virtual photons. These attempts fall into two basic categories. These are pulsed devices and rotating devices, the latter usually containing permanent magnets. Often the two approaches are combined. A third method uses a pulsed device in concert with a type of semi-conductor to form a virtual photon solar cell.

All these devices attempt to use the energy inherent in the ZPF, as well as attempting to scatter the ZPF in such a way as to produce cascades of virtual photons. Space itself may be the source of our future energy.

For more information on this and related subjects check out a newsletter called the New Energy News. Their address is P.O. Box 58639, Salt Lake City, UT 84158-8639. Phone (801) 583-6232.

Letters to Home Power

Flowers from Alaska
I just wanted to say how absolutely first rate and wonderful HP continues to be. I love looking back thru early issues for nostalgia's sake, but really, there's no comparison. You have truly empowered me. While I am by no means expert ion many AE areas, still, I am able to provide to provide good advice to convert the sunlight, wind, and water flowing over and around us so copiously (even here in the Far North) into useful electrical energy. My greatest joy is passing these skills on to others — training and empowering them, rather than just becoming their "expert".

I am writing mainly to report on our new Trace SW4024. What a wonderful machine! Balancing and prioritizing household and shop loads are a thing of the past. Even with big time combined loads, such as dishwasher, freezer (regular ac!), deep well pump garden irrigation, Makita table saw, lights, TV, etc., the inverter still has enough capacity to run big load dumping stuff (currently an ac water heater). I am doing this by using one of the auxiliary relays (5 A @ 120 vac) to trigger a larger 30 amp relay. On a sunny, windy day when the solar panels are putting out their 45 amps @ 24 V and the Whisper 1000 is honking at 30 to 40 amps at 24 V, this excess inverting capability ability to dump excess production into ac loads, while still handling household loads, has changed our whole management strategy. Otherwise, I would have to shut down the Whisper 1000. It does better in high winds feathering back and protecting itself, and the the new inverter allows this strategy.

Winter time charging of our 2000 AH, 24 V battery bank with a 4 Kw generator is about twice as fast as it was with the Trace 2012. Add to this the advantages of pure sine wave and high efficiency and ... what a winner! John Dailey, HC1 Box 3102A, Healy, AK 99743-9604

A Brainstorming Contest?
We are involved in (2) large recreational development projects consisting of about 650 and 1250 acres respectively. Each project entails a hotel (main building and 100+ rooms, clustered in groups of five to seven cabins), recreational facilities, self-sufficiency apartments and 50–100 private vacation residences. Our objective is to build an economically feasible environmental model community. Our problems involve transportation (40–60 miles offshore), construction techniques (energy efficiency, low maintenance, pre-fabricated, aesthetically pleasing, easy on-site assembly) and electric power micro and/or macro generation, power storage (preferably solely based on renewable energy).

Solar, wind, tidal, and wave power generation or a combination thereof all have potential. In order to succeed we need all the help we can get from anyone who has pragmatic ideas or who has practical experience beyond the stage of experimentation.

Do you think your readership might be interested in participating in a creative brainstorming contest? Do you think your advertisers are interested in participating in these projects and contributing among others their know-how?

At this time we are in the very preliminary development phase. We have recently commissioned various studies involving the general feasibility of the projects. We are considering proceeding with the smaller project and subsequently with the larger project.

If you think so, you have our permission to publish this letter together with our full address and phone/fax number so we can explore the possibility of a brainstorming contest, advertiser participation and perhaps a report series from inception to completion. Claus Mittermayer, Aerotronics Support Inc., 4 Gardiner's Way, PO Box 410, Shelter Island, NY 11965, 516-749-2202, fax 516-749-3303

YO Home Power!
What a great rag! Stumbled on it by sheer dumb luck several months ago, jaw dropping as I opened it and found gold inside. I was doubly amazed that it was one of the few magazines that didn't produce an avalanche of business reply cards upon opening! Finding it is such as pain though, that I think you'd better gimme a subscription and some back issues for catch up reading. Please send the back issues via a speeding teenager in a Camero.

In just a few years my two kids will be grown and this single dad, along with an old single buddy, will be flushing the "security and stability" of our mortgages, property taxes, utility bills, etc., etc., etc. He and I have purchased a couple of small RVs to live in and plan to go "nomad" when I have no dependants. After 20 years, we've both completely burned out on working full time and overtime just to pay for static boxes to live in. So we're going to sell our homes and try something different. Get our living overhead way, way, down and

live off the sale of our homes and minimum work for as long as possible. We may park in the official trailer/RV courts now and then, but as often as we can, park our "homes" away from civilization. Since we're both computer, photography, graphics and music fanatics, we're going to fix these RVs up over the next few years to handle the electrical needs of these hobbies. And not having to work full time will hopefully give us some "sabbatical" time for creative things. I guess we're planning to become "high–tech hippies" for awhile, if you will.

Home Power has been invaluable in getting a general focus on "portable" off-the-grid power. Our little ears really picked up with Joe Flake's "Going Solar" article in #38, and we started sweating and hyperventilating after reading Christian Brunner's "Burning Ring of Fire" in #40. That photo of Christian by his RV next to the river in the desert with his kayak and solar panel on top.. don't you people realize what pictures like that do to the time clock slaves in your audience?

At any rate, you've got our enthusiastic support! RE is eventually, inexorably going to snowball. Thanks again for the fantastic work! Brian Ellefson, 712 W 21, Vancouver, WA

Shortsighted?
I have read and thought about your opposition to utility companies becoming suppliers and servicers of photovoltaic systems. I BELIEVE THAT THIS IS A SHORT SIGHTED AND UNINFORMED JUDGEMENT ON YOUR PART.

I believe that if we are to survive on this planet, that we immediately need to start using renewable and non-polluting forms of energy. We should do all we can to bring this clean and effective method of energy production to the public's attention. As an owner of a home powered completely by solar power, I often meet people that are amazed that "it works" or that it is a cost effective alternative to grid power. The fact that Idaho Power and now some other utility in California wants to supply this form of clean power to some of their customers should be welcomed by all of us — including those who currently sell this technology.

The better known a technology or product becomes, the more applications and needs there are for the product or technology. I believe that the "independent dealers" that have banded together to stop "monopolistic utilities" (It is not my understanding that any utility has asked for a monopoly on photovoltaic systems, but merely the opportunity to sell or lease them.) from selling photovoltaic systems are mistaken on two counts:

1. Utilities will not steal their business— they will likely cause a greater public awareness and actually increase "independent" dealer business.

2. Independent dealers can and will provide superior service and expertise and good competition to the utilities, making the entire industry stronger.

As a small business owner myself in the telecommunications industry, I am well acquainted with the power of "monopolistic" utilities. I have been very successful at earning a living in their shadow. In fact, I often get customers just because they would rather work with little me, rather than a big company. I believe that the utility programs to provide PV should be viewed by independents as a powerful form of publicity and public education to prove the point that PV does work.

True Story: Several years ago, my wife and I started a retail business that was entirely new to the area. Though other parts of the US had supported such businesses, we found it difficult to educate the public that we were viable since no one here had heard of what we were doing. After a struggle to stay afloat, a competing business started up on the other side of town. Thru their publicity campaign and our previous efforts, we both grew our businesses. Moral of the story: When dealing with a new or unrecognized product, competition will often create more public awareness thus more business for all participants in the particular field.

Finally, I am embarrassed that you folks, part of the pioneering PV industry of the country, we are railing against a public utility's desire to sell PV on the basis that it will run you out of business. Poppycock. Compete with them, distinguish your service from theirs. Learn to improve what you do. Stand up and cheer that PV is finally getting AN ENDORSEMENT from the very "establishment" that many of us feared would never acknowledge the feasibility of photovoltaics.

If we really believe in the importance of renewables to our planet, getting the word out is critical. The decision by utilities to begin providing PV is a giant step in the right direction. I encourage you to think globally about what is best for all of us as you evaluate the meaning of the electric utility's entry into this arena. Fellow small business person, Matt Farner, Eagle MI

Hello Matt: Thanks for your thoughts. Like you, Cynthia and I live in a solar powered home and operate a small business doing something that excites us. We also share your global concerns and expect to see renewables make an increasingly significant

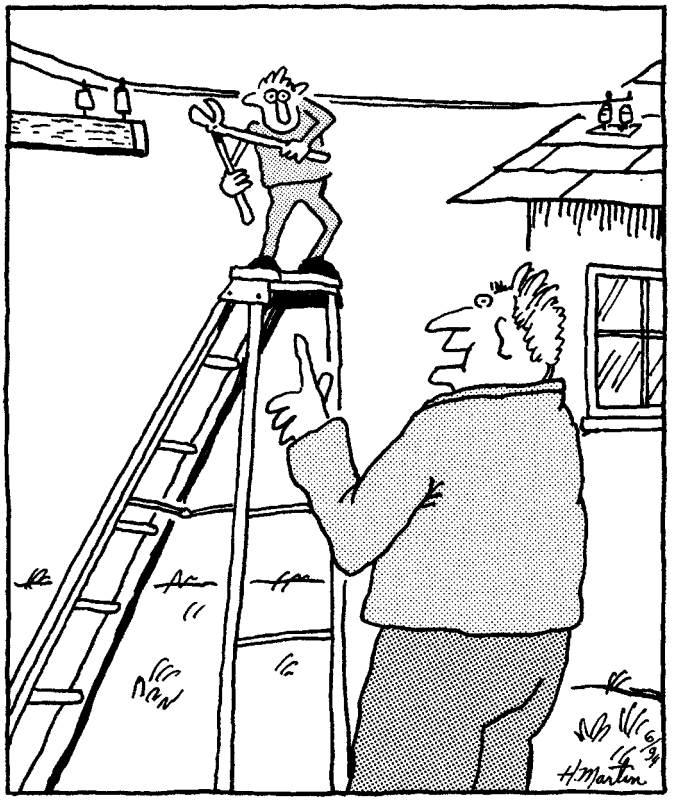
contribution in the future. In fact, we believe we are definitely part of the forces bringing that reality into existence.

Your arguments supporting utility PV service are not new. They are among many that SCE themselves presented in rebuttal to IPP arguments presented to the CPUC. As such I can accept them as assumptions supporting the utility perspective, but they certainly are not facts. To a certain extent, the program we are about to have here in California will test these assumptions. The rest of the nation should be cautious before assuming any conclusions.

You mention the benefit to your business when a competitor opened shop. I'm a little dismayed that you don't seem to know the difference between another business competitor and a monopoly. At the heart of my issue with utilities is that they are monopolies! Perhaps the American consciousness has glazed over a bit about why they are allowed to exist. I believe that monopolies are on the way out. Anachronisms of past times. As such, they will not be capable of leading the way to a new energy future. In a future of decentralized energy production, we can expect decentralized energy businesses. We expect to be there along with many more like us, flexible and responsive to our customer's needs, providing services and goods at competitive rates. It's the American way. How are monopolies justified in a free enterprise system that is healthy? — Don Loweburg, Offline

Hi Matt, Several years ago we felt just as you do. We've changed our minds. Would you buy something on time if the loan cost more than 100%+ of the base purchase price? To date, all of the utilities "rent to own" schemes would cost the end user anywhere from 100 to 200% more than of the original system cost from a reputable dealer. To use your True Story analogy, what if the company that moved into your area did such a poor job that the product or service appeared to be unreliable or outrageously expensive? How would your business have done then? — Karen Perez

Well, Matt, we disagree. Our planet needs renewable energy, not another power struggle. Energy is now something that can be home-grown. Utilities are in the business of selling energy. The democratically diffuse nature of solar energy doesn't lend itself to centralization. Based on the utilities' performance with nuclear power, I neither trust them nor feel that they have this planet's welfare at heart. I've been living on solar for twenty-four years. We don't need a profit-oriented utility to show us that solar works. Watch out! These folks want to rent us sunshine. If we don't insist on home-grown power, then it will be utility bills as usual. — Richard Perez



Far Sighted?
Our family moved off-grid several years ago. One of the main reasons for our move was to get the utility company out of our life for both financial and environmental reasons.

No matter how we cut back on our electric usage and conserved our utility bills went up and up. Our family has strong environmental values and is very anti-nuclear. I was happy to be able to stop paying bills to a company that runs dangerous nuclear power plants.

I have been following the discussion about utility company's wanting to enter the offgrid area. I am concerned that the effect of this move would be to eventually put the growing locally owned companies that are now providing this service out of business. There is ample precedence for this. I am old enough to remember the locally owned independent gas stations and how they were put out of business with price wars by huge oil companies and the locally owned grocery stores that have also gone by the wayside. I do not want to see this happen to the PV company that installed our PV system and our neighbors. Personally I do not want to see PV controlled or dominated by the same energy monopolies that own the Diablo Canyon and San Onofre nuclear power plants.

It is clear to me that the utilities lack any commitment to a clean, safe environment as long as those plants are operating and creating deadly waste for our future generations to have to deal with.

So if not for environmental reasons then why are the utilities interested in off-grid photovoltaics so well served now by a growing independent industry? In my opinion, it is because photovoltaic technology clearly makes it possible for people like me to choose to unplug and generate our own power. Over time more and more people will choose energy independence and the utilities will lose customers. I believe they would like to nip this trend in the bud. Jan Goldman, North Fork, CA

More Sun Frost Data
Hello from eastern South Dakota; the eastern fringe of "the great American desert". Things are great here. Winter's over and garden, grass, flowers, sheep, and Darlene are ecstatic. The PV system, Sun Frost and me are perking right along too. I enjoyed reading the Letters to Home Power concerning what other Sun Frost owners had to say about their units and wanted to share my numbers, now that I have some. Bought an Omni-Meter and have really learned a lot about my system since.

Anyway, during May, our kitchen temperature ranged from 70 to 85°F. The Sun Frost consumed on the average of 600 watts per day. The range was from 440 to 740 watts per day. A standard max/min refrigeration thermometer gave consistent back of the freezer compartment temperatures of zero +/- 2 °F. The back of the refrigerator stays at 37°F, +/- 3°F. The temperatures near the door vary as much as +/- 10°F, but most of that is due to fanning the door, and momentary in nature. The ice cream stays consistently frozen regardless of location, and the vegetables and meats keep equally well regardless of location, so there aren't any warm spots. This only makes sense with the well insulated walls, and the open nature of the refrigerator and freezer compartments on the Sun Frost.

Our household has Darlene, me and a teenage daughter, Sarah. We save energy because Darlene, is dictatorial about not fanning the SF doors, and getting food moved in/out at the same time, plus we are not into iced drinks. Now if I could just convince her of the massive amount of phase energy involved in thawing frozen food in the fridge. Cliff Millsapps, RT2 Box 147, Hartford, SD 57033

Thanks for the data, Cliff. Many Sun Frost users have been writing in about the performance of the units. We estimate that over 80% claim their Sun Frosts use less power than specified by Sun Frost. Sun Frost contacted Hallett Douville (see Letters in HP#41) about his Sun Frost which seemed to consume more than it should. The net result was a measurement error caused his RF-16 to appear to overconsume. We are still taking data on our RF-19 and it consumes an average of 1,045.2 Watt-hours per day. We keep freezer at 3°F. and the frig at 36°F. Richard Perez

Mailing Label Gremlins
I know that you do try to run this publication in an efficient manner but you did mess up on my last issue, which I received today and promptly read. Being a thorough reader I saw the note in the subscription notice and the picture and letter from Rick Niemi, so I checked my label only to be baffled. Plain English does usually mean just that so I was puzzled by the lack of plain English on the label. Upon checking my back issues I found that you normally do have stated in plain English on my label, "Your last issue #43". But not so on issue #41. Hope that you can chase that gremlin out of your closet! Keep up the good work. Mark Hack, Longview, WA

Hi Mark, Everyone who's last issue was #41 already knows what went down via a postcard, but for those of you who's last issue wasn't #41, here's what happened. The company that generates our mailing labels hired a new person who inadvertently dropped the "This is your last issue" line from #41s labels. OOPS!! We've taken steps so this, hopefully, won't happen again. So please keep checking your mailing label for plain English! Karen Perez

BBS Power
As much as I anticipate the arrival of each issue of HP magazine none have made the impact of issue #39. The introduction of Home Power BBS has brought to me (and many others) a wealth of information on renewable energy, from your earliest issues right up to the more recent ones. being a relatively new computer user I have not yet utilized your BBS to the fullest, but I find it a good incentive to learn. I particularly like to see home energy projects geared to the home handyman with average skills. Cliff Marshall (on Prodigy Armx 55A), Forestdale, RI

Jolly Good Idea!
I am a mature student for a Higher National Diploma in Engineering.

I am interested in alternative energy/technology (AT) and as part of the course I am planning a study tour of the United States from October to December of this year primarily visiting the states of Arizona, California, and New Mexico, but also visiting other areas if my schedule permits.

It is my intention to visit establishments, either organizations or private individuals who are working in the field of AT. Especially those that have successfully established AT as part of there lifestyle, and have been successful in reducing or removing their dependency on conventual energy sources. The aim is to assess the success of these enterprises and there suitability for application in the United Kingdom.

I would therefore be grateful if you know of any suitable places that I could possibly contact with a view to arranging a visit?

I thank you for your assistance and look forward to your reply. Andrew Kitts, c/o Lincolnshire College of Agriculture and Horticulture, Caythorpe Court, Caythorpe Grantham, Lincolnshire, Great Britain NG32 3EP

Hi Andrew, You would be very welcome to visit us here at Home Power. We are only one mile from California (but California is a very large state). Our whole neighborhood is powered by renewable energy. Hopefully, by printing your letter, HP readers in the states you mentioned will drop you an invitation. Steve Wade, Wind & Sun, The Howe, Watlington, Oxford, England 0X9 5EX, in your backyard, lives with renewable energy and undoubtedly knows others in your area. Good Luck! Karen Perez

Phantom Load Killer!

For those of us who couldn't or wouldn't program our VCRs, the Video Plus is just the ticket. All you have to do is punch in those little numbers in your TV listings and that's it. No more setting your clock because the VCR Plus is powered by a 9 Volt battery. So you can unplug your VCR, kill the phantom and not have to reprogram it ever again. Dick Sextone, Putney, VT

City Off-Grid

Love your magazine! I have all issues except the very early ones. Any news on making the articles available out of the first ten issues? I need more reading material!

I have been moving off-grid a circuit at a time. I have been adding panels and batteries to my system as I can afford it. Currently I have eleven sets of QuadLam PV and two Kyocera PVs up and running. Fourteen golf cart batteries provide storage, and a Statpower 1500 W inverter provides 120 vac. Bobier Electronics is building a UL power center so I can get on the right side of the electrical inspectors. Eventual plans are to add a Trace sinewave inverter and a Sun Frost refrigerator. (This 25 cu ft side by side monster is eating up all my solar juice!) A wind generator will be added when I move to the Mendocino coast in about four years.

Do you know of any source of computers that can supply low power consumption systems? The people around here say their 'puters use very little juice, but when you start talking watts, they change the subject. Seems they can talk gigabytes and other buzz words, but have no idea how many watts their units gobble up. I am writing this on an old AST 286 that draws over 100 watts not counting the monitor! I cannot leave my computerized weather program running 24 hours a day off grid! As my wife's job is geared to the IBM architecture and she has to use the home computer for work, Macs are out of the question.

Also, for the collection of items that won't run on modified sine wave, I have a Radio Shack clock radio with dual alarms. I guess I shouldn't say it won't run, it runs at twice speed on the clock! (time sure flies). I don't know if the new ones have that same problem.

Who says off-grid won't work in the city? Thanks for spreading the message! Bob Taylor, Huntington Beach, CA

Hi, Bob. The out of print Home Power issues are available on Internet or the Home Power BBS. See page 14 of this issue for access data. The number of people "going off the gird one circuit at a time" is truly astounding. We've received dozens of letters from folks using PVs on the grid. Check out the system saga on page 6 of this issue. Here's a fellow who would rather put his money into sunshine rather So Cal Edison. We were always told by PV pundits that grid folks wouldn't use PV until the price was lower than $2.00 per Watt. I guess these experts could learn something new about the power of the sun! If you couple PV with efficient power use, you have a combo that works right now!

Contact John Osborne at Aircastle Enterprises, 15941 Goldwin Place, Southfield, MI 48075 • 313-557-7961 for the scoop on super efficient computing equipment. Modern laptops and notebooks (we use a PowerBook 160 here) are very small consumers of power. In larger systems, it is the display which consumes about 75% of the power the system requires. Choose your display wisely.

It is very common to find electronic clock circuits that run double and even quadruple time on modified sine wave inverters. The clock circuit is counting the 120 vac wave front transitions, and perceives the radical voltage transitions of mod sine waves as additional cycles. Get a clock that uses a small battery and you'll get up on time. Richard Perez

EV Pen Pal

I am particularly interested in the articles on electric cars. I own a 1975 Citicar which I use daily for local transportation and am making slow progress in

converting a 1981 Pontiac T-1000 (Chevette) to electric. I have just recently moved to the Kansas City area and would be delighted if you could tell me if there are any other electric car enthusiasts in this area. Edward P Chancey IV, 1700 E 80th St, Kansas City, MO 64131

An Apprentice Exchange Program
Thought your readers would benefit from learning about this new exchange. Learning through apprenticeships is one of the most ancient and rewarding ways of acquiring knowledge. The set-up is simple. Two people work together — one person who wants to gain specific skills or knowledge, and another who is experienced in those particular areas. The Mentor Apprentice Exchange connects mentors and apprentices from all areas of North American.

More mentors are needed in the areas that your publication focuses on. Equipping apprentices with the tools and skills they need to build a sustainable future is one of the best gifts a mentor can give. Heidi Priesnitz, The Mentor Apprentice Exchange, Box 405, Canning NS B0P 1H0 Canada, 902-582-3046

Neutralizing Battery Spills
In the past, I have read about people who keep neutralizing agents in the case of a battery spill. The problem is that nobody says how much solution to use. I ran some numbers and here is what I found: If you spill sulfuric acid, use four times as much of a one-to-one lime solution. If you spill potassium hydroxide use half as much sulfuric acid, or twenty times as much vinegar.

These numbers are close enough to clean up fairly well. Mark VanPopering, Byron Center, MI

Thanks, Mark. Here are a couple of more equivalents. One pound of baking soda poured into one quart of battery acid will do a good job of neutralization. For alkaline electrolyte, I use one quart of Muriatic acid (from a pool supply store) to neutralize one quart of alkaline electrolyte. Richard Perez

Q&A

Radio Help

I would like to know more about good radio listening. We live in rural Alaska where there is no TV reception without a dish. We have no dish (have lived w/o TV for 18 years). We used to love radio, but the inverter kills that too. Before the inverter we had a small radio booster with a ground and antenna that would bring in radio. Some of the suggestions I've heard are 1. coax –100' to bare telephone wire & good ground; 2. giant 320' loop; 3. DC rod antenna with 100' coax. Would any of your experts have any suggestion for radio antenna that work with an inverter present or must the inverter be turned off. Going on six years with our solar system — I miss radio news. Too many things in Alaska politics affect our lives & we don't have any news just human pipelines for news. We only get a local small town paper with little or no statewide news. Sue Entsminger, HC72 Box 800, Tok Cutoff, AK 99780

Hello, Sue. All of us at Home Power are hams (amateur radio ops). We understand radio frequency interference (RFI) and what a problem it can be for radio listeners. The first way to reduce RFI is to eliminate it at the source. Either replace your inverter with one that produces less RFI, or do all you can to reduce the RFI in your present inverter. In my experience, the Exeltech sine wave inverters, equipped with their optional RFI quiet kit, have the least RFI of any inverter. You can add RF bypass capacitors (0.1µf disc ceramic rated at twice your battery voltage) between positive and negative poles of both ends of your present inverter's DC input cables. You can also twist your inverter's DC supply cables into a twisted pair. Making a spiral helix of the input cables vastly reduces the RFI that they radiate.

As far as antennas go, your needs are difficult to satisfy. First, radio signals are weak in your location because you are so far from their source. Second, you live in an RFI noisy environment (the inverter). Your antenna must be located as far as possible from the inverter. I like very long single wire antennas (end fed Hertz) for AM and shortwave listening. I use one here at Agate Flat that is over 400 meters long and made from 18 gauge galvanized, steel electric fence wire. In your case, locate any all parts of the antenna at least 200 feet from the house. Add a signal booster (RF pre-amplifier) at the antenna. Bring the already amplified radio signal into the house on high grade coaxial cable (RG 8U or better). The coax shields against inverter noise. Pre amplifying the signal at the antenna makes the radio receiver (in the house) less sensitive to inverter noise. Establish a good, deep ground rod just for the radio. Don't hook any power system equipment to this radio-only ground rod. Powering all the radio gear directly on low voltage DC from a separate battery (with no inverter or any connections to the main system) also decreases RFI. Antennas and RF pre-amps are available from C. Crane & Co., 558 10th Street, Fortuna, CA 95540 • 1-800-522-8863. They have a swell free catalog of all sorts of serious radio stuff. I've used their gear and it is first class.

Finally, check out your radio receiver. Modern general coverage receivers are more sensitive and able to resist noise than radios made even five years ago. In the moderate price range, I love our Sangean ATS-803A. If you are really addicted to radio, the ICOM's new general coverage gear is amazing! — Richard Perez N7BCR

Measuring Watts

I am hoping you or other readers of your magazine might be able to help me find an inexpensive watt meter and an energy efficient ac to DC power supply. I have been trying to measure the power consumption of various items used in my house. For larger appliances I either shut off power to all but one circuit and use the watt-hour meter on my house, or I use a watt-hour meter which the local power company loans to customers. Recently I have been experimenting with different ac to DC power supplies which I use for recharging small batteries, powering electronic equipment and operating small DC water pumps. Typically these use less than 20 watts and using a watt-hour meter gets rather tedious as I have to wait for long periods for the meter disk to make a complete revolution. I would like to locate a watt meter for say $100 for measuring 1 to 100 watts. I have also noticed that small "plug in the wall" outlet type ac to DC power supplies , which costs about $10 and deliver 12 watts at 12 VDC, require about 20 watts ac for an efficiency of around 60%. I have been told that they could be easily made to be over 90% efficient for an input of 12 ac watts, but the manufacturers generally opt to use the cheapest material and construction techniques. Since electricity is about $0.43/kWhr in many small communities in Alaska, a 7 watt savings can mean more than $25/year saved when equipment is left on continuously. Obliviously, I would be happy to pay more for an efficient power supply in such a case.

Thanks for your assistance. Michael Mauser, 1466 Carr Ave, Fairbanks, AK 99709

Hi, Matt. The most efficient type of ac to DC power supplies are now "switching supplies". See the article

in HP#40, page 70. Efficiencies in these switchers is approaching 90%. Any ac watt-hour meter with the sensitivity you require is going to be expensive (over $700). I suggest that you invest in a good digital multimeter (a DMM like the Fluke 87 or Wavetek 2020). This will cost you about $300. Both these meters will record average rms ac current in a variety of ranges. Simply record average current, multiply it by average voltage (117 vac), and multiply the result by the time in hours that the DMM was recording current. Presto, ac watt-hours! The advantage of the DMM is that it will record everything from micro amps to mega amps (with a shunt). Your measurement needs vary from the very small to larger appliances. Plus the DMM is a general all around good tool. Once you own one, you'll wonder how you got along without it. — Richard Perez

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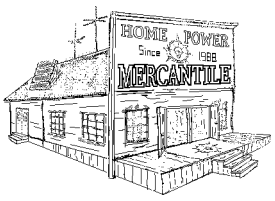

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